THE

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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TRADE IN AUSTRALASIA.

ALTHOUGH the electrical trade, being at present not of very great extent, may not be so deeply interested in colonial developments as some other departments of industry, still, in proportion, it is quite as important for it as for any other business to adopt the best method of reaching the extensive markets existing in such rapidly progressive countries as the Continent of Australia and the Islands of New Zealand. A pamphlet has recently been written by Mr. Louis Anson, who was resident fifteen years in Australia and New Zealand, giving some very interesting particulars of the modes of business prevalent in those colonies, calculated to enforce the argument that great improvement might be looked for if trade were transacted direct through a representative visiting the different towns and promoting business relations with consumers instead of being left in the hands of middlemen.

What the British exporter has to contend with is not competition with others from this country, but with the continental and American exporters who are rapidly gaining ground in these distant fields. British trade with the Antipodes is capable of great expansion, but present systems of mercantile intercourse will have to be abolished or re-adjusted. There is no concealing the fact that our competitors are filching our trade from us. Goods in which formerly Great Britain did a large business out there, are now almost entirely supplied by German, Austrian or American houses.

As regards Germany, the rate at which she competes with British manufacturers is really formidable. In ten years the Australasian imports from Germany increased no less than 346·1 per cent., while those from the United Kingdom increased only at the rate of 32·1 per cent. Australians are said to be hardly loyal to English traditions, but to have a tendency to copy American notions in the matter of dress and household decorations, and to be even louder in their tastes than brother Jonathan. In the selection of goods they are more critical of appearance than of intrinsic value and quality, and favour the happy medium rather than top prices. They like novelty, and are very ready to adopt new inventions. Electric lighting is no new method of illumination to Australians. The streets are ablaze with electricity, and the theatres are quite as brilliantly lighted as those in London. Their steamers are as fast as Atlantic liners, and are admirably fitted out with all the latest improvements, including electric lighting.

It is asserted to be impossible to work one continental colony from another; it is even more difficult to work New Zealand from an Australian centre, the mere matter of distances not being the only obstacle. The New Zealand people, it appears, are not in touch with the Australians, and manifest a spirit of insularity, separateness, and isolation. Already not a few British manufacturers have felt compelled

to have their own agents abroad, either solely occupied with their business, or engaged for them in common with manufacturers in other branches of trade. The reason is that shippers on this side, receiving indents from Australasia, are found not to be in touch with the markets for which they are commissioned to buy. Travellers representing Continental makers in the Colonies, on the other hand, take pains to study the precise requirements of wholesale and retail purchasers with greater care. Traders in Australasia send fewer and fewer orders for particular wares to the English commission agents, in consequence of their wants being more suitably met by Americans, Germans, and makers of other nationalities.

British exporters are advised to depend less upon the energies and exertions of general agents and uncolonised representatives, and to visit the countries for themselves; to band themselves together, and to be less lofty and more conciliatory when approached by colonists on questions of business. The foreigner's politeness often secures him orders that might have gone to an English firm had it manifested a similar desire to obtain them, and displayed in the effort a like measure of courtesy. If British manufacturers think the colonial trade worth cultivating, they must rely less on the shipper, and push business direct through agents acting immediately for them on colonial ground; men who will study the tastes and promptly meet the requirements of their kinsmen in this group of prosperous colonies.

THE GENERAL ELECTRIC POWER AND TRACTION COMPANY.

ON the principle, possibly, that two minuses make a plus, the businesses of The Electric Traction Company and Messrs. Immisch & Co. were, as from January 19th, 1890, formed into one concern, under the title of The General Electric Power and Traction Company, which was registered in May of that year. The Electric Traction Company had had a previous existence as the Electric Traction Syndicate, and in that state had, on January 19th, 1888, obtained the option to purchase the Immisch business after the expiration of two years from its date.

During this two years' interval, the Syndicate had developed into the Company, and the Company, exercising its acquired option, bought up Messrs. Immisch & Co., and sold itself to The General Electric Power and Traction Company for £212,000. The new company was floated under the auspices of the Electrical Construction Corporation, who sold them a license in connection with the E.P.S. accumulators for £30,000. The first accounts, submitted in December, 1891, were made up to September 30th, 1891, at which date the capital expenditure stood at £246,660 18s. The accounts submitted to the meeting held on Tuesday last are made up to September 30th, 1892, and show that during the year £11,500 has been added to capital account, making it £258,160 18s., but that a net sum of £38,896 5s. 8d. has been written off this account for depreciation, so that it now stands at £219,264 12s. 4d. Stock and work in hand, which last year was over £30,000, is now £14,374.

Debts due to the company amount to £10,000 less this year than last, while debts due by the company are almost exactly at the same figure as last year, and so is the cash in hand. The pruning knife has been used freely, £59,871 12s. 10d. in all having been cut away as dead. In addition to this, there has been a loss of £4,009 3s. 11d. on this year's trading; and the head office expenses, £5,549 17s. 5d., are gone never to return. The net result is a loss of nearly £70,000—being over one-fifth of the paid-up capital.

Considering that the first year and eight months of the company's working produced a profit of £2,476, the shareholders, to put it mildly, must be bitterly disappointed.

The directors of electrical companies, instead of profiting by the failures of their *confrères*, seem impelled to imitate them. There is hardly a large company in the trade which has not gone through the form of trotting out its fat year, or years, and then exhibiting one of appalling leanness, which more than swallows up all the fat, and still remains lean. Perhaps some day there will be an Official Valuer of Companies' Assets; or without him directors will have discovered the way to trim their assets yearly, instead of having a grand lopping and topping at irregular intervals.

There is many a good electrical scheme hung up at the present time for want of funds wherewith to carry it out. The confidence of the public is required, and will not be obtained by alternate inflations and collapses of profits. The one negative will destroy the effect of several affirmatives.

The directors have been much too sanguine, as they own in their report. Traction has not answered expectations, in consequence of the state of the roads; neither has propulsion, because of that of the weather. Much money has traction drawn away, bringing in return, as the directors naively say, "much valuable experience." The Barking Road venture has not been a financial success. The traction directors having pointed out to tramway directors the errors of their ways, the latter refused to mend them. The two companies could consort no longer; the electric cars were taken off, and the venture became a loss. Here, again, is a fact not calculated to inspire confidence in the minds of those who may, at some future time, be asked to put money into electric traction. In this case it is storage battery traction; but the public can hardly be expected to draw fine distinctions, or to know that the method has never yet had a really fair trial. The storage car is heavy, and needs a strong road. The tramway companies have their roads laid down, their leases running out, and their pockets not too full. The Traction Company has all along believed in the system, and made a good fight as long as it was able; but circumstances have been against it. Given a specially constructed road and a full complement of cars running through streets with plenty of traffic; then, and then only will the question of the storage battery *versus* the horse be settled.

It is now on copper depositing that the directors pin their faith. They have purchased Mr. Parker's patents for £20,000, and are fitting up works at Millwall.

Although on the face of the balance-sheet the assets are £68,299 less than the liabilities, and consequently the capital is not intact, and no dividend can be paid, if earned, until the capital has been reduced; the Company is still in a financially strong position. It has £31,098 of liquid assets and £26,000 of uncalled capital, making together £57,098. Moreover none of the assets are mortgaged, which is more than many electrical companies can say. So that after deducting the liabilities (exclusive of capital)

£9,248, and balance due for the Parker patent, £10,000, together with any future cost of equipping the Millwall works, there should still be amply sufficient funds wherewith to carry on business. "The directors are hopeful that they will be able to present a much more satisfactory report at the end of the current year." We hope so, too.

The Vienna-Buda Pesth Railway.

IT now seems reasonable to assume that this remarkable scheme has been abandoned. Projected by M. Zipernowsky, the railway has only existed on paper, and on paper it is likely to remain, if we accept as correct the statements made the week before last by Mr. J. Kareis, of Vienna. Mr. Kareis said that if the proposed line were constructed, and could obtain the whole of the present annual traffic of 200,000 passengers between Vienna and Buda Pesth, the working results of the railway would not allow of any interest being paid on the invested capital, without even taking into consideration the question of depreciation. This is based on the assumption that the line would cost to construct no less than two and a half times that of building an ordinary railway. It is, however, difficult to understand how the comparison is made, since a train on the electric railway would consist of a single car carrying only 40 passengers. It is nevertheless believed by Mr. Kareis that the construction expenditure would be diminished by reducing the proposed speed to 93 miles an hour. We should imagine that under the circumstances the project may be considered as definitely shelved.

Registration of Mortgages on Machinery.

DEBENTURE holders in electrical companies may be interested to know that according to certain recent decisions machinery in a hired mill has been held to be a realisable asset in a case of foreclosure. Although put in at the expense of the tenant, and attached to the building merely with an object to steadiness, machinery so fixed is a "fixture," and as such can be seized for the landlord's debt. The law seems to need amendment. On the 10th inst. Mr. Mundella received a deputation from the Associated Chambers of Commerce, who wished a clause inserted in the Bill now introduced by the Lord Chancellor, which deals with the whole question of bills of sale, to the effect that no mortgage of buildings should include machinery unless the agreement creating the same be registered as a bill of sale. Debentures are excluded from the scope of the Bills of Sale Act, because they are secured on the general assets of a company and not on merely personal chattels. The idea is that trade creditors should be protected by a knowledge of what they can and cannot, in case of necessity, seize; and from the manner in which Mr. Mundella received the deputation there is little doubt the matter will be fully looked into.

A Side Light on the Rubber Industry.

THE electrical world will probably be unanimous in agreeing that the gutta-percha and India-rubber industry can scarcely be regarded as being established on an intelligent or indeed intelligible basis. During the last few years we have been accustomed to attribute all the troubles which we experience in this direction as due to the improvident treatment of the native supplies; and there, undoubtedly, is much blame to be attached to those who control these supplies. But are those whose business it is to manipulate the raw materials beyond censure? Professor Campbell Brown threw a startling side-light upon this question when he declared the other day that chemistry had little control over the manufacture of India-rubber, for the simple reason that the chemist did not know anything about this substance! So we presume this important industry is, even in these days of technical education, being carried on chiefly by rule of thumb. Here surely is one of those golden opportunities which so seldom occur for the chemists to gain *kudos*, and do the great electrical industries a lasting service, moreover, there is the certainty of the price of gutta-percha going up very much more in the market during the next few years, and this alone ought to stimulate chemists to the task of setting the manufacture of this material upon an intelligent basis. Is there nothing to be done in finding a substitute that shall commend itself to the uses of the electrical engineer? Cannot the old or "perished" rubber be turned to better use? In connection with this latter question it must be remembered that the problem of the de-vulcanisation of scraps and old rubber has been before the trade since vulcanisation was first practised, but it cannot be said to have yet been solved. In these days of feverish activity in commercial matters, one wonders whatever the chemists can be thinking of.

Ionisation.

THE term *ionisation* originally applied by Fitzgerald to that modified dissociation which is supposed to consist of a slackening of the bonds which hold the ions together in a solution, has now received the approval of and been adopted by J. Traube. This scientist, whose researches in physical chemistry, especially that branch of it which covers electrolytic dissociation, are well known and have played a prominent part in the polemics of "the great controversy," has now practically adopted the hypothesis of electrolytic dissociation in order to explain the behaviour of aqueous solutions of metallic salts. He contends, however, in a paper which may be consulted in the *Berichte der Deutschen Chemischen Gesellschaft* (Vol. xxv., pages 2,989—2,993), that the dissociation into ions need not be a complete dissociation, such as the followers of Arrhenius are inclined to favour, but only this slackening of the bonds which hold the ions together, which he now calls "ionisation."

The Formation of Magnetic Minerals in Furnaces.

AN examination, recently made by B. Doss, of the sublimation products in the furnaces of the Hermania Soda Works at Schönebeck, has revealed the curious fact that several substances, hitherto only found in nature, may, under the conditions existing in these furnaces, be accidentally formed. It is not so remarkable perhaps to learn that amongst these furnace products such substances as anhydrite, hæmatite, iron pyrites, or even specular iron ore are found, but it is certainly very curious that magnetite and magnetic pyrites should be produced under such extraordinary conditions. Doss merely contents himself with stating that he has recognised these magnetic substances amongst sublimation products; he suggests no reason for their formation.

Mr. Campbell-Swinton's Experiments.

WE have recently referred to the interesting conduction effects obtained by Mr. Campbell-Swinton, and Mr. Tesla contributes a short article on them to the New York *Electrical Engineer*. Mr. Tesla considers that a considerable factor in the lamp experiment (in which an ordinary lamp was lit by a current passing through the operator's body), is the effect of the rarefied air as a dissipator of energy. This lateral dissipation of energy he considers to be mainly responsible for the high potential differences often observed with currents of the character here employed, potential differences capable of causing large sparks.

TRAIN LIGHTING.

AN interesting experiment in train lighting by accumulator batteries is now being carried out on certain of the cars of the Chesapeake and Ohio Railway, which is exceedingly well spoken of by the *Electrical World*. In the principle of the application, that is in charging accumulators at a depôt and transferring them to cars or carriages, there is nothing new. It has been pursued over and over again; but there is a completeness in carrying out this experiment which should, so far as the system itself is concerned, insure success. A very complete charging depôt is provided within easy access of the cars. Lines of rails, on a 2 feet 6 inches gauge, are provided between the charging racks in the depôt and continued to the point where the cells have to be transferred from the trolley which is provided for the purpose of conveying the cells between the two points. This trolley is so arranged that the platform on which the cells is carried can be raised or lowered at will by the attendant in order to place it upon the same level as that to which the cells have to be transferred. The cells are then slid into their position, whether in the receptacle provided for their reception in the cars, or on the racks in the charging station. Labour is thus reduced to a minimum, but at the cost, as will be observed, of a slight sacrifice in the space required for the miniature 2 feet 6 inches line of rails to and from the cars.

The accumulator cells are said to be constructed upon a novel method. The system is that known as the Silvey system. Weight has not been regarded as an all important factor. The power to withstand hard usage has been allowed to exercise more influence, and it is asserted that the course pursued in the method of making and arranging these cells, has resulted in no such thing as a short circuit, or buckling of the plates, during the two and a half years they have been in operation. The plates consist of a metal grating, 6 by 12 inches square, and about $\frac{1}{8}$th of an inch thick. Twenty-one constitute a complete battery cell. These lead plate castings are then subjected to an electrical treatment original, it is said, to the Silvey system, the interstices being filled with electrolytically deposited spongy lead, after which they are placed in a bath, which is said to harden the spongy lead into a firm coherent mass. The plates are coupled up by means of a lead screw with washers and nuts —a method long since abandoned in this country. It is said that the plates thus formed afford a "useful working output" of about 22 per cent. of greater efficiency than do those formed of lead oxide.

Between each set of plates are arranged sheets of a porous separator, treated so as to become practically indestructible in the electrolyte, and which are large absorbents of the same, so that the cell has a very near approach to a dry cell; the liquid held by the separating material being sufficient to afford full action of the cell. In order to prevent the splashing of any free liquid on top of the plates, the cell is made deep enough to admit of a sort of wooden crate being used on the top of the plates, so as to form a breaker for the surplus liquid. Each cell is enclosed in a hard rubber case, and six of these are connected in series in a long wooden trough provided with rollers. Two such troughs, making 12 cells in all, are the complement for a car.

Each car is provided with 8 16-C.P. lamps in the body of the car, and a vestibule lamp on each platform. The lamps are said to be of 25 volts. The batteries are placed in cupboards underneath the bed of the car, one at either end.

It is said these cells, having a rated capacity of 30 ampères discharge, have frequently been entirely discharged at the rate of 120 ampères, and charged at the rate of 100 ampères, without sustaining any injury. It is added that cars are frequently away from the charging station for two weeks together, the cells being in no way affected by their thus enforced idleness.

The cost of equipping and maintaining 50 cars, 144 C.P. to each car (say, 9 16-C.P. lamps) for 15 hours per day, or 5,475 hours a year, is given at, for two sets of cells and car equipment, inclusive of charging plant, $34,441.00 (£7,175), about one-fifth being the cost of the charging plant. The maintenance of the same is set forth at $3\frac{3}{10}$ cents per car per hour. Covered by this is 6 per cent. on outlay, 10 per cent. for depreciation on charging plant, and 15 per cent. on equipment. The cost per lamp would therefore appear to be something less than one farthing, say $\frac{4}{5}$ths, per hour, and the cost per unit of current evolved from the batteries about $3\frac{1}{2}$d., a very satisfactory result, and one which we hope may be sustained. The weight carried by each car is stated to be 1,857 lbs., as against 1,900 lbs. the weight of cylinders, &c., for Pintsch's gas, the relative cost of which is given as 6·97 cents, or twice that of the electrical system.

ELECTRIC TRAVELLING CRANES.

IN a paper read before the American Society of Mechanical Engineers, Mr. A. Victorin gives an interesting description of an electric travelling crane in use at the army gun factory, Watervliet Arsenal, West Troy, N.Y.

The crane is operated by a single (flat-field) electric motor. The electric current is generated by a Thomson-Houston 65 horse-power dynamo. Its voltage is 500, the speed 1,020 R. p. m. The crane has a span of 60 feet, a clear hoist of 40 feet, and a capacity of 120 gross tons. The capacity of the auxiliary hoist is 10 tons, hoist 56 feet. The total weight of the whole crane is about 150 tons. The bridge rests on eight double-flanged wheels (four on each side) of 36 inches diameter, the trolley on 16 wheels of 24 inches diameter. All wheels are arranged in pairs in compensating beams to avoid inconvenient results from want of uniformity in the level of the track rails. All wheels have also anti-friction steel roller bearings.

The motor is located at one end of the bridge. It receives the electric current through a bare copper wire, which is strung on insulated rollers along the crane ways. The motor is in permanent gear with the clutch-shaft, which is fitted with four clutch-gears.

Two square driving shafts are located on the bridge, one on each side. One shaft operates, by means of clutches, the bridge travel and trolley travel and the auxiliary hoist; while the other operates similarly the main hoist only.

The crane performs the following operations :—

Bridge travel	= 40 and 80	feet	per minute.
Trolley „	= 50 „ 100	„	„
Main hoist	= 2, 4, 8 & 16	„	„
Auxiliary hoist	= 20 and 40	„	„

Automatic brakes are provided to sustain the load in any position. The trolley is provided with two grooved chain-drums, each being capable of winding 250 feet of $1\frac{1}{4}$-inch wrought-iron main hoisting chain. These chain-drums revolve loose on a trolley axle-shaft 7 inches in diameter, with bronze-bushed bearings of 24 inches length at each end of drums.

The lower chain-sheave block contains 6 bronze-bushed sheaves 30 inches diameter, while the upper block contains 5 sheaves of 33 inches diameter, each of which swivels independently of the others. The chain is rove twelve times through the sheaves. The chain-drum of the auxiliary hoist is located above one of the main chain-drums, and is grooved for a $\frac{3}{4}$-inch chain of sufficient length for 56 feet hoist.

The operating cage contains all manipulating levers, also the main switch, rheostat, &c., and all motions of the crane can be in operation simultaneously.

All gears of the crane mechanism are carefully cut, except the gears on the chain-drums, which are cast. All bearings have bronze bushings. All working surfaces are finished smoothly and all parts are carefully adjusted.

But, notwithstanding all possible care with respect to the construction and the arrangement of the crane mechanism, a great percentage of the driving power is absorbed by friction; and the maximum efficiency of the main hoist is only about 40 per cent., the lowest efficiency being about 20 per cent.

It may reasonably be assumed that the friction in the mechanism for the bridge travel and the trolley travel attains similar proportions, as given for the hoist: and that the efficiency ranges from about 25 per cent. for the slowest speeds, with the greatest number of gear trains in operation, to about 50 per cent. for the highest speeds, with fewer parts in operation.

The figures in the table permit various calculations as to

the frictional resistance in certain parts of the crane, as follows :

Theoretical work of hoisting 120 gross tons 2 ft. p.m.	= 16·3 H.P. = 24·3 ampères.
Actual work of hoisting 126 gross tons 2 ft. p.m. ...	= 50·27 H.P. = 75 ampères.
Frictional resistance in crane	= 33·97 H.P. = 50·7 ampères.
Actual work of operating hoist 2 ft. p.m. without load	= 10·05 H.P. = 15 ampères.
Frictional resistance due to the load of 120 tons ...	= 23·92 H.P. = 35·7 ampères.

It was observed that the power required to bring the crane mechanism up to speed from the state of rest is considerable, and is from about 30 per cent. to 150 per cent., in excess of the power required for keeping an operation in continuance.

ELECTRICITY v. GAS.—TRAIN LIGHTING.

IT is often interesting, and at times even amusing, to compare the views expressed by advocates, eloquent of the interest which they affect. The following is taken from an article which recently appeared in the *Electrical World*, dealing with train lighting.

"If the general public was only aware of the facts that, in each tank under the car there is stored a gasoline vapour under a pressure of not less than 150 lbs. per square inch, and that in this apparently harmless cylinder there is enough energy which, if ignited by any accident, will blow a train of cars to atoms, State legislation would be invoked to peremptorily abolish this most potent danger. An allusion to only three accidents where this messenger of death has done his work is enough to call the attention of the people to a painful realisation of undesirable facts. A gas tank exploded on a passenger car near Nantes, France, wrecking the train, and, without a moment's warning, launching 200 passengers into eternity. But coming nearer home, within the present year (*i.e.*, 1892), a number of accidents can be recited caused by the explosion of gas on cars, among which the explosion of the gas on the Chicago and Erie Railroad near Lima, where the pipes sprung a leak, the gas became ignited from the conductor's lantern, wrecking the car, and consuming the wreck before the fire could be extinguished."

From our contemporary, the *Practical Engineer*, we cull the following concluding remark of a paper on "The Lighting of Railway Trains," by Mr. Harry Pollitt, of the M. S. & L. Railway, read before the Owens College Engineering Society on the 1st inst.:—

"As to the electric lighting of trains, according to the best known system—that involving the carriage storage—it would only be necessary for injured passengers to be blinded and scarred by the spilt acid of the batteries, to raise a louder clamour against the importation of this superfluous risk into railway travelling, than that which is now being so factitiously manufactured by interested electrical people, out of an erroneous report respecting the misbehaviour of compressed gas."

We make no doubt that the authors of both these statements are very experienced and very competent men, quite capable of determining the advantages or disadvantages of either mode of lighting in its application to suffering humanity in case of accident, and that on the whole it would—as we assume Mr. Pollitt suggests—be better to be entirely consumed by fire than that our clothing or our person should be injured by the diluted acid. It is clear no one could read the concluding remark in Mr. Pollitt's paper, if correctly rendered as above, without at once acknowledging the peculiar impartiality which characterises it. We give the extracts in each instance for what they are worth, without in any way attempting to vouch for their accuracy, merely as instances of varied opinion. We should like to know, however, if Mr. Pollitt *has* read Major Marindin's report on the collision which recently occurred near Clapham Junction, when three vehicles were rapidly reduced to ashes, and a company's servant badly burned by the escaping gas, consequent upon the collision. Has he considered what would have been the effect had those vehicles been full of people, instead of being—as they were—empty ?

MESSRS. BAGSHAWE BROS. & CO.'S "STANDARD" TUBULAR SYSTEM OF WIRING.

THAT the present method of running wires in wooden casing admits of modification and of improvement, there can be little doubt, but any system which is brought forward as capable of superseding it, must fulfil a number of requirements in a more satisfactory manner than the present system. If this is not the case, then the most that can be said is that the new system is applicable only to certain special cases.

Nearly all the existing systems which compete with the usual system, depend for their superiority upon more complex conditions, calling for a higher grade of skilled labour. At the present day it is difficult to find wiremen who can be trusted to make a satisfactory joint between two wires. What, then, are we to expect in practice from systems which have special joints, requiring special tools, and specially trained men to make them ?

Messrs. Bagshawe Brothers have recently introduced a tubular system of wiring. It is hardly correct to call it a system, as, of course, there is nothing new in running electric wires in tubes. The novelty consists in the tubes being made of a material which is claimed to be a non-conductor and incombustible. The "system" is very carefully worked out, illustrations being given of many forms of joint box, bend, elbow, socket, &c., and of tools for joining two lengths of tubing, and so forth.

Let us consider for a moment the desiderata of an ideal system of wiring.

(1.) It must admit of easy examination at any time, and facilities should be afforded for testing and tracing the circuits.

(2.) The risk of fire from electrical causes must be minimised.

(3.) It must be very simple, so as not to call for special skill on the part of the workmen.

(4.) The materials used must be as few and as cheap as possible.

There can be no doubt that as regards the first of the above conditions, the tubular system of enclosing wires cannot compare with casing and capping. As to fire risks, these are dependent more on the system on which the circuits of wires are run, and on the quantity and quality of the insulation of the wires, than on the mechanical protection afforded for the wires. Casing is only used to avoid injury to the wires when being fixed in their places, and to ensure the lead and return being kept a certain distance apart throughout the length of the circuit. Casing is not used for insulating purposes, and if local conditions are such as to render casing unsuitable, another path should be chosen for the wires, or if this is impracticable, some suitable mechanical device must be resorted to, the details of which will be suggested to the competent engineer by the exigencies of the case. The tubular system cannot compare with casing on the score of simplicity and cheapness. It is highly probable that under peculiar circumstances, or in special cases, such a system of mechanical protection for the wires might be very useful, but it cannot be said to be on the whole a more desirable system than the one at present in use.

Electric Traction in Berlin.—The General Electricity Company of Berlin has adopted what may be a good method of furthering the introduction of electric traction on tramways. A company, called the General Local and Street Railway Company, has recently issued bonds, and it turns out that the General Electricity Company holds practically the whole of the share capital of the former concern. By this means it is hoped that a stepping-stone to the introduction of electric working will be formed. This is partly being realised by the adoption of electricity on the Dortmund and Chemnitz lines of the tramway company mentioned.

THE INFLUENCE OF IMPURITIES, &c., ON THE CONDUCTIVITY OF COPPER.

THE influence of traces of foreign matter occurring as impurities, or added with intention, is very marked in the case of metals and alloys. We have frequently called attention to it during the past year, and some recent experiments by W. Hampe, showing the modifications produced by traces in the electrical properties of copper may be cited in further illustration of this important subject.

Hampe obtained pure copper by treating copper sulphate solution with caustic potash until a considerable precipitate was thrown down; the solution was then heated for some time, filtered, and the filtrate subjected to electrolysis. The deposited copper, after being boiled and washed, was dried and fused with copper oxide, first in a current of carbon dioxide, whereby any residual copper sulphate is dissociated and the sulphur expelled, and finally in a stream of dry hydrogen, whereby any oxide is reduced to metal. The copper so obtained contained no impurity save a faint trace of antimony.

With this purified copper Hampe proceeded to prepare samples containing very small but known amounts of arsenic, antimony and silicon, observing all the care that a skilful metallurgist could possibly bring to bear in making these alloys—for such they were—of accurate composition.

The following table shows the absolute strengths, relative conductivities and densities of the various alloys examined:

	Absolute strength per 1 sq. mm. cross sectional area.	Relative Conductivity.	Density.
	Kilos.		
Pure copper	34·6	100·00	8·9565
Alloy i. (0·2161 per cent. arsenic) .	41·6	61·05	8·944
„ ii. (0·351 „ „) .	51·1	50·15	8·947
„ iii. (0·808 „ „) .	48·9	29·96	8·932
„ iv. (0·260 „ antimony)	52·0	68·07	8·948
„ v. (0·529 „ „)	54·9	56·50	8·946
„ vi. (0·526 „ silicon)...	50·0	28·11	8·870
„ vii. (3·472 „ „)...	95·3	6·50	8·471

The ductility of the alloys was about the same as that of pure copper, with the exception of sample No. iii., which was somewhat less ductile. More data are given in the original paper, in which Hampe describes his investigation, but these are more particularly interesting to the metallurgist, and may be consulted in the *Chem. Zeitung*, xvi., pp. 726—728. It should be added that the value 100·00 given to the electrical conductivity of copper was fixed arbitrarily for the purposes of comparison.

The Permeability of Certain Membranes.—During the past two or three years we have briefly noticed several researches by Traube, Ostwald and others, on the permeability of precipitated membranes. Traube holds that these membranes are of the nature of "molecular sieves," which prevent large molecules from passing through them, whilst permitting the passage of smaller molecules. Ostwald has developed this theory, and has gone further, stating that these permeable membranes may exercise a sort of selective action, allowing particular ions to pass through them, but not being permeable for salt molecules as such. Salts, of which both ions could pass the membrane, would pass through as a whole; whilst if one of the ions were stopped, the salt could not pass at all. This idea has recently been tested experimentally by G. Tamman, with the result that the theory based upon it does not strictly hold. He considers that Traube's and Ostwald's views are untenable without modification, and inclines to the opinion that the process of passage through the membrane may be one of solution, since all the semi-permeable membranes with which we are acquainted are strongly hydrated.

HOT WATER STORAGE.

By W. H. BOOTH.

THE writer has frequently called attention in the pages of the REVIEW and elsewhere to the importance of large water contents in steam boilers. He has been as strenuously opposed by the upholders of little boilers with large fire-grates. In electrical work, more than in perhaps any other description of steam plant, this item has been overlooked, and boilers of minimum capacity have been employed in far too many instances. With a perversity of naughtiness, we now find that, though the errors of small water capacity are at last beginning to be seen, yet the method for carrying the same into effect is to be, in appearance, different, as though a salve or sop were needed to mollify those who have blindly refused credence to the necessity of heat storage. The new idea for thermal storage, which is the fashionable and elegant verbiage for that which engineers have coarsely called boiler room, provides for vessels to contain water of high temperature from which, when required, a supply of steam may be drawn to meet a sudden demand. Hitherto we have been told that the disastrous effects of the explosion of a Lancashire or Cornish boiler have been due to the sinful amount of water which these boilers contain. Under the new system, of course, the water will behave differently. It will be made hot, and forbidden to exert any pressure until required! Presumably the boiler proper is to be of some tubular variety, but, hidden away, muffled up in a corner, is to be the thermal store pot. What is to become of the much-vaunted economy of floor space, which "makes the tubular boiler so eminently suited to central stations in high rented cities?" The one advantage in separating the water storage from the boiler proper lies in the ability to employ simple egg-ended cylinders absolutely without stays, and therefore exposed to no local stresses, as the water holders, and to tack on to them any variety of boiler which may be desired. The proposal is in reality a concession to the established fact that no boiler has yet been constructed which will give the all round satisfaction for large powers that is given by the large bodied class of steam generators, but this concession is to be given without apparent retreat from a position which is rapidly showing itself to be untenable, and it is kind of Prof. Unwin to point a road out of the difficulty which will bring folks back to town without returning along the turnpike. Put into other words, the idea resolves itself into a system of working the boiler at a much higher pressure than the engines are worked at, instead of at only 2 to 5 lbs. higher, the steam being taken through a reducing valve, so as to give a uniform initial pressure on the pistons. There is nothing novel in this idea, but, with the advent of high pressures, it becomes important to divide the steam boiler into sections having different temperatures. This is largely carried out in practice by the use of flue feed heaters ("Economisers") in which the feed is often heated to boiler temperature. This, of course, is not desirable, for to a great extent it defeats the object sought to be attained, namely, a considerable difference between the heat-absorbing surface and the heat yielding gases, and in such cases the chimney temperature is unnecessarily high. What is required to attain a low temperature is a sufficient sub-division of the boilers to properly utilise the fuel heat by some arrangement of counter currents better carried out than at present. Indeed, present practice is the practice which grew up to suit boiler pressures of 30 lbs. To burn fuel economically, and to have boilers worked at 250 lbs., it is easy to see that the feed-heating gains an importance not hitherto proper to it, for the boiler surfaces themselves were so comparatively cool that given a large surface the gases would get away at a reasonably low temperature. Now, this is impossible without a rationally divided feed-heating surface, and to make the storage of water a success economically, this must be done. There is no reason to doubt the possibility of fairly protecting the water cylinders from radiant cooling, nor to doubt the perfect

practicability of the idea. It commends itself to those who have advocated large water capacity, and it should be fully as acceptable to the low water men also, for it affords a means of rendering their boilers far more useful than they can be alone, and it relieves them of the necessity of making statements anent floor space occupied, the advantages of small water capacity, and the power of quick steaming, of which they must by this time be pretty sick. One thing is certain; we shall hear very little of the quick steaming qualities of water tube boilers when they have a thermal tail to wag. Water storage must be a good thing for the engines; it is far more important to have a steady steam pressure than to have a large engine, and engines of the high-speed Willans type will gain by the adoption of the idea. We have been told in the past that the heat stored in a big boiler is all wasted when the engines are stopped. Even if this be so, a few figures would demonstrate that the loss would not be large, and it becomes a smaller percentage with every increase in running time. The same loss, such as it is, must inevitably accompany the thermal storage system, but it is hardly necessary to point out that those in charge would be unfit to hold their positions who did not run the later minutes of their time with heat from store rather than from the fire. With small water capacity it is necessary, on the other hand, to work big fires well to the end of a run, for the heat goes so very rapidly to the engine in the absence of an equalising mass of water. This loss of fuel must go a long way towards eliminating the supposed advantage of such a boiler, but it is a loss which has been quite unrecognised by the advocates of the type, or at least not admitted. We are reduced, therefore, to the more disastrous effects of an explosion consequent upon large water capacity as to which any difference may well be compared to the proverbial hanging for theft of a lamb—might as well have been a sheep. Though differently arranged, it is not to be denied that the thermal storage tanks are simply so much boiler capacity, the chief difference being that between a spade and an implement for digging. By all means let the word thermal be dragged in, if thereby we can be treated to a sounder practice.

NOTE ON THE PURIFICATION OF MERCURY.*

By M. W. JAEGER.

At the German Physico-technical Institute, the mercury intended for exact measurements (the construction of standard resistances, barometers, &c.), is subjected to the following purifying processes. The metal used is mercury sent from the Idria mine in iron bottles, and is of very good quality and fit for use for most purposes after simple filtration.

In order to eliminate the heavy metals which may exist in it, the mercury after having been filtered and dried is first subjected to a double distillation *in vacuo*. In this operation it is necessary to avoid the slightest trace of grease or other impurities which might be introduced through greased taps or India-rubber tubes. For this reason, a mercury pump without any tap is used, the closing being effected by means of columns of mercury; the connection between the pump and the distilling apparatus is also made entirely of glass without any tap. After the air is exhausted the communicating tube is drawn out and sealed hermetically.

As mercury purified by distillation may still contain electropositive metals (alkalies, zinc, &c.), it was thought necessary to subject the metal to a second purification by electrolysis in order to dissolve these impurities. The liquid used for this purpose is a mercurial solution of nitrate, obtained by the action of nitric acid on mercury in excess.

* *La Lumière Electrique.*

In order to render the current density as small as possible the current was divided between four vessels of the same dimensions. These vessels were formed of an outer glass cylinder A (fig. 1), about 19 centimetres in diameter and 11 high, containing the mercury purified by distillation and serving as anode, and another inner glass cylinder, B, 9 centimetres in diameter and 3 high.

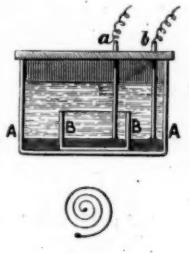


Fig. 1.

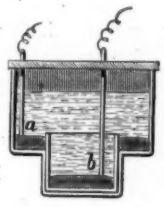


Fig. 2.

This latter contains the platinum cathode, *a*, wound in a spiral.

When a certain quantity of mercury has been deposited, so that the bottom of the inner vessel is entirely covered with it, its whole surface acts as a cathode, and the density of current is still lower. The current is conveyed to the mercury in the outer vessel by another platinum wire, *b*, insulated from the liquid by a glass tube. The total surface of the cathode is thus 260 square centimetres, that of the anode 900 square centimetres. The source of the current was a Gülcher thermo-electric battery, which, with an internal resistance of only ·4 of an ohm gives from 3·6 to 4 volts. By means of a resistance the current was maintained at about 1 ampère, at times it went up to 3 ampères. With this last intensity the deposit of mercury was again effected under good conditions. (In this last case, the density of current is about ·012 of an ampère per square centimetre for the cathode and ·003 for the anode.)

One drawback to this method is that at the end of a certain time the anode becomes covered with basic salt which eventually entirely stops the current. The liquid surrounding the anode becomes more and more concentrated and only spreads upwards very slowly, while the excess of salt is being precipitated. This defect can be remedied by another arrangement as shown in fig. 2. When the anode, *a*, is at a higher level than the cathode *b*, the solution concentrated by the current descends in consequence of its greater density and displaces the weak solution in the inner glass, so that with this arrangement a continuous flow of liquid is established.

The chemical examination of mercury purified in this manner has been effected by M. Mylius, who gives the following results.

To detect heavy metals, we proceeded as follows:

(1.) 200 grammes of the material were distilled in a current of oxygen; a few milligrammes of crystallised oxide were obtained. This was dissolved without any residuum in the nitric acid. The solution evaporated in a porcelain crucible and heated up to volatilisation of the mercury, left no trace of residuum.

(2.) 200 grammes of the material were treated at a low temperature with diluted nitric acid until only two grammes of material were left undissolved; this remainder, which would contain the platinum, if there were any, from the electrodes, was separated and dissolved in nitric acid; on being evaporated and volatilised in a porcelain crucible, the solution left no appreciable residuum.

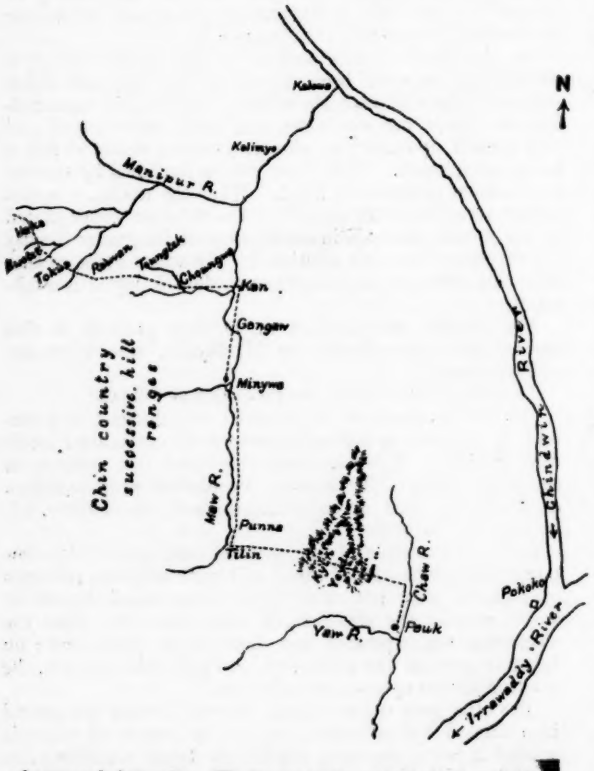
The other part of the nitrous (nitrate) solution was poured into diluted hydrochloric acid. The mercurial chloride washed in water was quite capable of being volatilised; to the filtered liquid was added some ammonia. The precipitate of ammoniacs, mercurial chloride, was heated with diluted formic acid and mercurial chloride was obtained, which was separated by filtration, and which, on being volatilised left no residuum. The filtered liquids containing ammonia and formic acid were collected and evaporated. The ammoniacal salts, destroyed by nitric acid, were volatilised; only a small residuum remained, containiug alkalies, lime and silicium; these substances were attributable to the glass vessels used.

The foreign metals constituting the impurities of the mercury would be contained in this residuum, the systematic analysis of this latter revealed merely traces of iron; it is probable that this was attributable to the employment of various iron utensils in the course of the operations. In 200 grammes of purified mercury no impurity consisting of any heavy metal was to be found; the spectral analysis for the detection of light metals has not yet been made. The Idria mercury, taken directly from the iron bottles, is very pure, but it leaves after volatilisation an appreciable residuum.

THE CHIN COLUMN TELEGRAPH EXPEDITION.

By F. E. DEMPSTER, Superintendent of the Burma Division of Indian Government Telegraphs, Rangoon.

IN 1889 the Government of India decided to send two expeditionary forces to explore the country lying in the triangle between Burma, Arracan and Manipur, and to pacify and bring under control the wild tribes inhabiting these desolate hill tracts. One force was to start from Arracan and operate in the Lushai country, the other, starting from the Irrawaddy, was to operate in the Chin country. The forces were to meet if possible. With each force was sent a telegraph party, and it was hoped that through telegraphic communication would be effected from the Irrawaddy into Arracan. The following narrative deals with the experiences of the party working up from the Irrawaddy. As the lines laid were only temporary field lines there was little technical difficulty, but as an instance of the adverse circumstances under which telegraph work in the Far East has sometimes to be carried on, it is believed that this account may prove



of general interest. The country in which these operations took place is, even now, so little known that an occasional reference to the accompanying map is necessary to render the account intelligible. The place where the troops were to concentrate, and which was to be the base of the expedition, was a village called Kan, which lies in the valley at the base of the Chin hills. Before any field lines could be laid with the troops it was therefore necessary to connect Kan with the telegraph system of the country, the most advanced office of which was at Pauk, a village 46 miles from Pokoko on the Irrawaddy, the furthest point to which stores could be transported by steamer. Information of the country between Pauk and Kan was very meagre and unsatisfactory. There were isolated police posts at Tiliu and Gangaw, but for all our purposes the country might be considered uninhabited. A road was under course of construction between Pauk and Gangaw, but, as will be seen later on, it was not of much service, except that it determined the route the wire should follow. Distances from place to place were unknown or guessed at, so anything like an accurate estimate of our requirements was impossible. In order to be on the safe side, 100 miles of wire, weighing 600 lbs. per mile, with insulators, brackets, &c., for a semi-permanent line, Pauk to Gangaw, 100 miles of a wire weighing 150 lbs. per mile for the field lines beyond Gangaw, and 100 miles of a wire weighing 300 lbs. per mile to be erected when the final route from Kan to Haka, the main objective point of the expedition, had been decided on, were obtained and sent to Pokoko. Stores for officers at Tiliu and Gangaw, and field equipments for six field offices were also obtained. These stores began to arrive in September, 1889, at Pokoko, and a large storeyard was formed there, and on the 24th of that month I assumed charge of the field lines. The work I had before me was first to get all the stores transported to Pauk, 46 miles away. Then to distribute the heavy 600 lbs. per mile wire from Pauk to Gangaw, 93 miles, ready for erection, and to carry the rest of the stores to Gangaw, so as to be ready to start erecting the 150 lbs. per mile wire with the troops. All office stores had to be sent on, and, in addition, rations for the whole working party, and for such transport as I might be able to obtain. No reliable information as to the probable dates of the military movements was available, except that by the first week in December the troops were to be concentrated at Kan or Gangaw; so little was known of the country that it was not definitely settled till later on from which of these two posts the advance should be made. I had, therefore, two clear months to get all the distribution mentioned above carried out through a wild, almost unknown tract of land, and in addition nearly 100 miles to get up in working order. Even with every circumstance favourable the task was no light one, but in the face of the difficulties met with from the very commencement, it was herculean. In a civilised country it is hard for people to realise how difficult it is to obtain carriage, local labour and food supplies in an alien or new country. It will be noticed in all books of travel the difficulty explorers always experience in getting, even at a ridiculously high price, the commonest necessities. This difficulty is very marked in Burma and in Upper Burma, which had been then lately annexed, and which was still in a disturbed state, it was acute. The transport for the military was, in September, beginning to be assembled at Pokoko, and after a good deal of solicitation, permission was obtained to send a large consignment of the 600 lbs. wire to Pauk to be distributed thence to Tiliu, 52 miles further on. The ponies and mules being very small, the roads being bad, and above all to avoid the slightest risk of rendering the animals unfit before the troops needed them, the wire was issued in 50-lb. coils, each animal carrying two coils, or 100 lbs. The monsoon rains should have ceased ordinarily by September, but, unfortunately, the season happened to be abnormal, and rain was incessant. The road, for about 30 miles from Pokoko, was fair, but there commenced the difficulties. Pauk lies in the fork between two rivers, the Chaw and the Yau, which unite a few miles south of it. Owing to the continuance of the rains, one or other of these rivers was in constant high flood; this made the fords alter, and as quicksands abounded, crossing was a matter of extreme difficulty, and in many instances danger. On arrival at Pauk the first check occurred. What with the rain, the damage done in crossing the rivers and the weak state of the ponies and mules, the convoy had to be stopped, and instead of the wire being distributed for 52 miles, it was simply dumped down in Pauk. This experience, unfortunately, made the transport officers very shy of carrying wire, so the local civil officials were importuned to obtain carts, and after some delay these carts were supplied in driblets, each batch as it arrived being laden with stores and despatched to Pauk as fast as possible. The rain still kept on, and the roads ultimately got in such a state that one

batch of carts took 14 days going the 46 miles. The last batch of stores did not arrive at Pauk till Ootober 31st, a significant proof of the difficulties met with at the start.

After many urgent appeals to the military, 10 elephants were placed at my disposal, and packing rations, coolies' kit, and tools thereon, I started for Pauk, glad to get actually out on the work. While the stores had been coming to Pauk, the subordinates I had sent there with the first batch of wire had been busily engaged in getting it sent on by the new road to Yeydu, 25 miles out, up to which point it was reported that the road had been finished. At this first start I had three upper subordinates, nine natives of the permanent trained staff, and 110 coolies; of these I left one subordinate to send on stores from Pokoko, one was in charge of the distribution on to Yeydu, and subsequently beyond that. The third was a man who had intimate knowledge of the Burmese character, and he was sent on to Gangaw to arrange for wooden posts for the permanent line, and to see if he could possibly arrange for coolies and food supply *en route*. On my arrival at Pauk, the first batch of carts that had been sent to Yeydu with stores had returned with very discouraging accounts of the state of the roads. The 10 elephants were sent on at once to Yeydu to distribute the wire from there, and on October 1st wiring from Pauk was commenced in heavy rain. The road consisted of an unmetalled track, with temporary bridges winding through the dense scrub jungle. The wire was run up as near the road as possible on trees, zig-zagging across it as suitable supports were found. Time was of such importance, and the stores collected in the division had arrived so fast, that a start was made before any rope arrived. The wire, consequently, had to be hand strained for the first 15 days. The men were all new to the work; the jungle cutting was very heavy, so that the progress at first was very slow. Owing to the continued rain everything was soaking wet, the heavy traffic of carts and elephants over the new unconsolidated road had churned up the surface into a veritable slough of despond. By October 10th, 11 miles of wire was up, and I moved camp 11 miles out. In this camp jungle fever made its unwelcome appearance, and five men had to be sent back to Pauk dangerously ill. From this date until I reached Gangaw, I only once had less than 25 per cent. of my men ill, and several times there were more than 80 per cent. on the sick list. By the 19th I got the wire to Kyiu, just beyond the point up to which the road had been completed. Kyiu and Yeydu lie in a small valley between two ranges of hills, over both of which the road ran. Over the first range the road was in an almost indescribable condition. Elephants sank in to their girths; carts had to be dragged through the gruel-like mud with their axles resting on the surface, and the wheels not nearly touching the comparatively firm soil below. Carts took from two to four days crossing this range, which was only seven miles, and many bullocks died of sheer exhaustion. The difficulty experienced in making the cart men stick to the work, the heavy manual labour involved in helping the carts and bullocks through, and the general gloom and discomfort caused by the incessant rain, can be better imagined than described. Knowing that carts could not go beyond Kyiu, further representations had been made to the military for transport, and just before reaching there I received the cheering intelligence that I was to get 20 more elephants, making 30 in all. I also heard that the subordinate I had sent on with the 10 elephants to distribute the wire beyond Kyiu was lying very ill at Tiliu, so off I rode there. In the thin, haggard man who met me, I hardly recognised the stout, cheery telegraph master I had despatched in high spirits a little more than a fortnight before. He and the transport sergeant in charge of the elephants had been so ill that distribution was at a standstill. They were both brought into my camp, and a big parade of the 30 elephants ordered for my inspection. My party was thus increased by about 60 men, for all of whom, as well as my own men, every pound of food had to be carried on to the work from Kyiu. One elephant carried one day's rations for the party, so extremely detailed arrangements were necessary to get our stores distributed, our party moved and provided with food as well. Having made all arrangements a fresh start was made, and the subordinate I had sent to Gangaw having returned, he was sent in to Pauk to send me out the stores and rations I required. The rain still kept on, the jungle was soaking; to stand in anything but a foot of mud was unusal; dry clothes were unknown; little wonder, then, that a few miles further on there was, one black Sunday, a general breakdown of the whole party, including myself. On that never-to-be-forgotten day every man in camp was more or less ill, and only about ten men were able to stand. For several days before this the rain had been so incessant, that we could only work an hour or two each day. From getting slight abrasions on the feet and legs into which the lime in the mud entered, a large proportion of the men suffered from sore feet. The flesh between the toes was attacked; it turned white and seemed to granulate, and a crack appeared, which in some cases extended up to the main joints of the toes. Of course the men thus attacked could not walk—could hardly stand. Owing to the tremendous delay in getting stores on from Pokoko to Pauk, my case of medicines had not arrived, so I had to beg or borrow from all sides. Owing to the courtesy of the engineer in charge of the road, I got a supply of quinine and simple dressing from his stores at Tiliu, so I was able to doctor the men to a certain extent. The severe cases were sent back to Pauk as opportunity offered. The Monday after the black Sunday above mentioned I was surprised not to get the rations I had already ordered out from Pauk, so tottering with fever, I had myself hoisted on to an elephant's pad and started back. On arrival at Pauk I found another subordinate had arrived, and a day or two after, the last batch of stores, in which I was glad to see a large chest of medicine, came in. Directing one subordinate to follow with stores and join my party as soon as he could get carriage, leaving one in charge of the stores and the third to get carts and start making the line semi-permanent, I returned to the working party, whom I found encamped at a cheery little village called Punna. The rain had lessened, and it really seemed that we had reached the long looked for end of the monsoon. A couple of days rest, treatment with quinine, dysentery pills, and simple dressing, and the unwonted luxury of getting thoroughly dry, inspirited the whole party. During these two days I had only 10 men sick—my minimum sick list.

But we were not yet out of the wood. As far as Tiliu the road had been, if not finished, at least well and unmistakably cleared through the forest, but beyond this clearing had only been done in places. The tracks used by troops the year before lay on the banks of the Maiv river, and the new road was supposed to run parallel to this some two miles or so away. Distribution, now, was a matter of extreme difficulty, as the Mahouts constantly missed the may; and in many cases, owing to the jungle and broken nature of the ground, could not get within half a mile of the line. A great part of the distribution had therefore to be done by hand. Ultimately we found the road had not been marked out at all, and the jungle simply impenetrable, so the line was carried on to the old track, and the new one abandoned.

After holding off for a few days the rain came down again, and the general enfeebled state of the party was shown by a general breakdown about 13 miles short of Gungaw. I could not walk, nor could my subordinates. Two of the sub-inspectors, all the linemen but one, nearly all the Mahouts, and 80 per cent. of the coolies were entirely *hors de combat*. I could only muster one sub-inspector, one lineman, and 15 men for work. The subordinate whom I had ordered to follow me caught me up here, so putting myself and the rest of the sick into doolies and on elephants, we went into Gangaw post for treatment. Five or six days after the wire reached Gangaw, and 26 comparatively fit men out of my original working party came in. As may be imagined, I had experienced great difficulty with my working party, who were so disheartened and frightened by the constant fever, that it required the utmost tact to keep them from bolting in a body. Again and again, when moving camp, it was doubtful whether they would go on or turn back. At Gangaw the party were weeded out, and all sickly men, and those who were unwilling to go on, were sent back. I considered myself lucky in having had, so far, only six deaths among the party. Curiously enough, these included the only Burmans I had on the work. We had now a rest, though erection of the surplus wire I had was continued towards Kau. All the elephants had been sent back to hurry up with the 150 lbs. per mile wire and field office equipments. By this time the troops were on the move, and the General commanding arrived at Gangaw on December 5th. His

first orders were that all the elephants were required for the troops. Very luckily one batch of elephants, with 57 miles of 150 lbs. wire and several field office equipments, had just reached Kau. Had it not been for that my arrangements would have been crippled, as the next batch of wire did not reach Kau till January 15th, 1890.

The wire being an uninsulated one, and the rain having been incessant, of course telegraphic communication was impossible till the jungle dried; all that I could do was to have a current kept on the line from Pauk for a certain time every day; each day I put on my galvanometer and got the beat, which showed the connection was right though communication was impracticable. Though the rain was now ceasing, there was a heavy fog every morning which wetted the jungle as much as rain would have done. Communication on the uninsulated line was hopeless till the rain stopped, so work was delayed simply because signals could not pass. At last, one day, I got a few readable beats at Gangaw from Tiliu, so leaving my head sub-inspector to get on with the erection of the wire, I rode into Tiliu, and on December 9th got Gangaw fairly well; we also got a few signals through from Pauk, but very weak and variable. I made up every cell I could, put them on, and rode off to Pauk, arriving there the same day. Arrived at Pauk, fresh batteries were made up, and every expedient to make the line work was tried. Parties were sent out to insulate the line with field insulators over the two hill ranges, where the fogs were very heavy. Again and again we could work well for a few minutes, and just as I hoped that communication was established, it would fail. Finally, on December 14th, we reported open with Gangaw, and almost the first telegram that passed informed me of the death of the subordinate I had left at Gangaw well and hearty. Four days after that Kau was opened. Very unfortunately I was again prostrated with fever for nearly 10 days. However, on the 27th, I scrambled on to my pony, and made my way back to Tiliu. Rain had again been general from December 23rd to 26th, which resulted in an enormous block of traffic at Tiliu, aggravated by the military signallers indulging in a general quarrel all down the line. My arrival at Tiliu, however, soon put that to right, and the block was so reduced, that I was able to leave for Gangaw, where I arrived on January 4th, when the block was finally cleared. As we had no rain to speak of after that, communication remained excellent, and gave no further trouble. At intervals subordinates and men had been sent out to me, most of whom had returned sick, but now an officer joined the work at Pauk, greatly to my satisfaction. Leaving instructions for the working of the lines and system from Pauk to Kau, I hurried on to join my working party who had followed the general out beyond Kau, and had reached a point about 10 miles behind him. I was now thrown completely on my own resources for transport; occasionally I managed to get a batch of Burman coolies to bring out wire in bulk, but all distribution, transport of kit and stores from camp to camp, was done by my attenuated working party, in addition to the heavy jungle cutting and erection of the wire. Before leaving Kau I was relieved of charge of the section Pauk to Kau, another officer being appointed to make the line permanent; I was then left free to attend to the erection of the wire with the troops. This wire was a light 150-lb. per mile one, the gauge which is usually used for field lines. Looking west from Kau, the whole range of the Chin hills was visible, a tangled mass of ranges rising one beyond the other, and all covered with dense tree and small scrub jungle. I knew the objective points were Yokwa and Haka, but where, or how far away these were, no one knew with certainty. Having only 57 miles of wire, I was very anxious on this point, and strained every nerve to get the remaining wire, which was slowly working its way up from Pauk, on to Kau. In this I was most ably helped by the officer who had just joined. By this time the main body of the troops had moved on. Luckily for me, their progress was slow, as they had to make a 7-foot mule track as they went along. Kau was a veritable hot-bed of fever, and was full of sick officers and men; fresh detachments of sick arrived from the front daily with reports of dense jungle, fearful malaria and heart breaking by steep hills. We, however, were so saturated with fever and quinine, that a little more or less really did not signify. It was now quite dry, and the actual work was lighter, so the men were more cheerful. Acting on a suggestion of my head sub-inspector, I had expended a large sum in buying every sort of spice and condiment dear to the native palate, and to which he is so accustomed, that deprivation means dysentry and general predilection to disease. These spices are not included in the field rations issued to troops, so my party were jubilant when they got them. After much trouble and irritating delays I got a party of Burman coolies and started out to the working party, carrying as much wire as I could. On January 12th I opened a temporary office at camp Choungwa, which, owing to the non-arrival of military signallers, I had to work myself. Every day we toiled up the steep hills, running the wire up on trees, distributing it with our own men along the track, clearing jungle, then, returning to the camp very weary, batch after batch of telegrams had to be despatched; with all this was the ever-present remembrance that the General was getting farther and farther on. On January 16th the wire reached Camp Toungtek, 28 miles from Kau, and here, again, a field office was opened. At this camp had occurred shortly before, the only resistance offered by the Chins to our advance; here, also, two days before, an officer of the King's Own Scottish Borderers regiment had been shot from an ambush. The General was now at Camp Rawvan eight miles further on, and so I was within easy communication with him. A day or two after my arrival at Toungtek he sent me a batch of about 60 Chins to carry on my wire and stores. Though strong, hearty men, they looked on the bundles of wire and field office equipment boxes with such suspicion that the whole 60 only carried about 25 full loads. At Toungtek two military signallers joined me, so I was at last relieved of doing signaller's work in addition to everything else. We got into camp Rawvan on January 20th, only to find the general had gone on to Yokwa, eight miles further on. Still hurrying on, I at last managed to get the wire into the general's camp on January 26th, and could then afford to take things a little more leisurely. Daily, on my way up from Kau, convoys of sick going back were met, but we, as we got higher and higher up the hills, managed to pick up a little strength, and what with care and the invaluable spices, I had very little sickness. The country was very difficult to get over. It was one tangled mass of valleys, some as much as 3,000 feet deep. The upper slope of the hills were more or less rounded, but the inferior slopes were almost precipitous. Where we came across Chin cultivation, the slope was so great that the soil had to be kept in place by tree trunks laid horizontally on the hill side, the whole hill looking terraced. The jungle on the inferior slopes was almost impenetrable, and though I kept as close to the track as possible, still there was a tremendous amount of clearing to be done. Near Toungtek we came across pine trees and rhododendrons, and the air seemed purer and more healthy the further we got from fever-stricken Kau. The camp offices I have mentioned were small huts, made of crooked branches lopped off the nearest tree, with grass hurdles for walls and roof. The instrument table was a box; the seat, the ground. Thanks to my assistants' admirable arrangement of the traffic at Kau, and to the help afforded by the officer who was working between Pauk and Kau, we were disposing of our traffic very fast. A day or two after our arrival at Yokwa, the delay on urgent messages from Rangoon was less than two hours, and on deferred less than 24 hours; we got the daily Reuter's telegrams, and felt ourselves quite in touch with civilisation. At the general's wish no further advance was made till the mule track had been well pushed on, so advantage of this stoppage was taken to give the coolies a thorough rest, and to hut them as well as possible. The traffic arrangements of the system were thoroughly overhauled and amended; with the help of occasional batches of Chin coolies, and the unwearied exertions of my assistant at Kau, we got more wire and office equipments pushed forward, till at last I got enough wire on to carry me well beyond Haka, which we had now learnt was only 18 miles further on. At last, on February 4th, I received permission to go on, keeping pace with the road, which, by then, was completed about six miles further. Camp Bwetet was reached on February 9th, and then it came to be a race to get into Haka the same day as the troops did. I was informed the general meant to march in on the 15th, and would not wait for the completion of the mule track, so I went ahead too. The next five miles up to the top of the high range, beyond which Haka was, was our most trying bit of work. Having gone

ahead of the mule track, we had to go by the Chin paths. These Chin paths go straight from one point to another, it being a matter of indifference to a Chin whether the path is level or on a slope of 1 in 2. On these hills the level bits were very few and far between. Of course, camping on the work was out of the question, so day after day the same steep hills had to be climbed, and at the end it took the coolies, who were carrying the wire and tools, three hours to get on to the work. Our progress was consequently slow. On the 13th, to my intense mortification, the general and the troops marched in to Haka ahead of me. However, I managed to get in there myself on the 15th, the date originally fixed. There was a further long halt here while negotiations with the tribes were being carried out, but after a few days I was allowed to run up another six miles to the border of the Haka territory. The coolies, who were now very expert at housing themselves, were engaged in building a substantial office hut, and huts for me and themselves. Arrangements were also made to get posts cut the whole way along on which to insulate the wire. Traffic had also to be watched and managed. In the end of January, again in February and in the middle of March, we had heavy rain, during which, of course, work between Haka and Kau was stopped. Each of these stoppages meant a block of traffic which required a great deal of management to work off. At last, in the end of March, there being no prospect of a further advance, and being completely worn out with sickness, I handed over charge and returned to India. The actual effect of the sickness which raged among my party may be thus summarised: out of four Eurasian and European subordinates who joined me between September and November, one died and three were sent back sick, one of whom subsequently rejoined. Out of seven linemen, one died and four were invalided. Out of 110 coolies 12 died and 60 invalided. The work done may be thus summarised:—187 miles of wire were erected in 96 working days, very nearly an average of two miles a day. This included cutting a route through heavy jungle nearly the whole way. In addition 65,000 lbs. of stores had to be distributed over an average lead of 35 miles over villanous roads and through very difficult country. Rations, stores, and kit for 160 men for the first 60 days, and 50 men afterwards, had also to be carried. We carried and distributed altogether a rough total of 89,000 lbs. of stores, kit and rations over 180 miles, with 30 elephants and an average of 75 men. Taking into account the sickness, discomfort, and general difficulties of the work, the result may be contemplated with some complacency. In case it may be thought that there is too much "*quorum pars magna fui*" in my narrative, I must hasten to add that though the responsibility and administrative details lay on my shoulders, all my efforts would have been paralysed had it not been for the devoted manner in which I was helped by the permanent staff, and by the coolies too. From my assistant to the junior lineman, including the traffic staff, one and all vied to make the work a success, and it is entirely due to this that the lines were laid at all.

REVIEW.

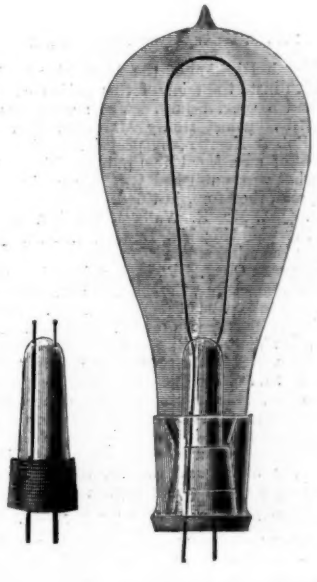
Transformers. By CARYL D. HASKINS. London: E. and F. N. Spon.

This work professes in the preface to be "of special value to the central station electrician, the student and the investigator," and yet so simple as to come within the scope of the general public. The book itself proves the impossibility of writing a book which can be of special value to practical men, students, or scientists, and yet popularly treated for general readers.

A book with the object in view revealed by the clause in the preface which we have quoted is certainly a somewhat ambitious work. We find, however, that it is a very elementary treatise on induction by variable currents, stating well-known facts and describing phenomena which every central station electrician, electrical student or investigator, must have been taught when he was a boy in an elementary science class; no book of this class seems to be considered complete without the theory of the transformer mathematically considered. In this work Hopkinson's theory and formula are given in Chapter III. Then we have the inevitable historical chapter, "The evolution of the transformer," beginning with Faraday's ring, which, by the way, is wrongly described. The ring is said to be of cast-iron. Faraday's ring, everybody knows, was of $\frac{7}{8}$th inch wrought-iron welded. The bulk of this book is made up by long descriptions of a number of commercial transformers, with illustrations such as may be seen covering the advertisement pages of American electrical journals, the elaborate cast-iron boxes, plates, and fuse blocks, taking very prominent places, while such an interesting subject as the construction of constant current transformers, giving a constant current in the secondary with constant pressure on the primary, is dismissed with the excuse that its introduction might prove confusing and irrelevant. The author states that such transformers are made; the description of their construction would have been of great interest to central station engineers, students and investigators.

THE NEW WESTINGHOUSE SEPARABLE LAMP.*

IN this lamp, as will be seen, the pear-shaped globe is retained, but its lower end is given a shoulder, and is thickened out considerably, after the manner of finishing the neck and mouth of a bottle. The interior of this opening is conical in shape and carefully ground for the stopper. The latter is also of glass and is ground to fit the bottle neck, but is continued within as part of the seal. The whole is a single piece, which is cast around the leading-in wires in the process of manufacture, thus constituting a seal throughout



the whole length of its major axis. An innovation in this portion of the lamp is the substitution of iron for platinum in its construction. This has been rendered necessary for two reasons. In the first place, the method of casting the seal around the wires rendered the employment of a metal not fusible at the temperature of molten glass imperative. Platinum is too expensive, and iron was found to answer. In the second place, the plan of the lamp, which is complete without the usual base, required the terminals to be strong

* New York *Electrical World*.

enough to withstand, without bending, the lateral strains to which they are subjected when making contact with the circuit terminals in the socket. For this purpose iron was well adapted, and to increase the rigidity the terminals were made large, as shown in the cut.

The filament, having been attached to the leading-in wires, the stopper having been covered on its bearing surface with a varnish or cement, is tightly introduced into the bottle-necked receptacle, and exhaustion of the bulb through the opposite end is proceeded with. In this latter operation, the specifications of the Sawyer-Man patent are followed, nitrogen gas being from time to time introduced and withdrawn again for the purpose of entirely washing out the remanent atmosphere with its accompanying oxygen.

The atmospheric pressure from without tends to more tightly seal the stopper, and the cementing material, which is elastic, is warranted not to crack. By warming this it softens, allowing of the removal of the stopper on admission of air to the bulb, but the atmospheric pressure prevents its accidental removal or loosening in use.

As seen in the cut, the lamp is complete without base. By simple pressure its shoulders are held in springs in the socket, and a twist of 90° brings its terminals in contact with the circuit terminals and the lamp is brought to incandescence.

Simplicity is one of the striking characteristics of the lamp, and the manufacturers seem to have accomplished their purpose of cheapening its manufacture without seriously cheapening its appearance.

The question which most naturally arises is, will not the greater coefficient of expansion of the iron leading-in wires cause a cracking, and, therefore, a leakage in the seal. The manufacturers claim that experience proves that it does not.

LEGAL.

TIBBITS *v.* ALABASTER AND OTHERS.

IN the Queen's Bench Division of the High Court of Justice, on Wednesday, the 15th inst., the trial of this action came before Mr. Justice Mathew and a special jury. The action was brought by Herbert Tibbits, M.D., against Henry Alabaster, Tom Ernest Gatehouse, and Harry Robert Kempe (the proprietors of the ELECTRICAL REVIEW), in respect of an alleged libel published in that paper. The defence was that what was published was fair criticism on a matter of public interest, and, therefore, justified.

Sir R. Webster, Q.C., Mr. R. Wallace, and Mr. R. A. Germaine were counsel for the plaintiff; Mr. Lawson Walton, Q.C., and Mr. Bankes appeared on the other side.

Sir RICHARD WEBSTER Q.C., M.P., in opening the case, said that it was in some sense remarkable, though it might, under the direction of his Lordship, not take very long in hearing. The action was brought by Dr. Tibbits in respect of what would not be disputed by his learned friend, Mr. Walton, to be so far as the terms of publication were concerned, a libel in the sense that it imputed misconduct as well as ignorance to Dr. Tibbits. It might be possible that an attempt might be made, under cover of this defence, to embark on issues which were not directly relevant to the matter between the parties, and if that were so, his Lordship would direct the jury that such questions were not relevant. Dr. Tibbits was a medical man of very high qualifications, being an M.D. of the University of Edinburgh, and possessing, in addition, considerable qualifications in England; and he had for a long time been interested in what was called "massage and electrical" treatment of complaints. He (Sir Richard) did not refer to specific diseases which could be cured by surgery or direct medicine, but that class of infirmities to which persons were subject without there being any real tangible causes which could be pointed out by medical men. The defendants were the proprietors of an electrical paper who had thought fit to make a series of attacks upon the treatment that would be the subject of discussion in this action, and to include therein anybody who had expressed an opinion, however honest his opinion might be, and however well-grounded, having regard to his own investigation. There had been established at 52, Oxford Street, for some years an institution on which a very large amount of money—between £40,000 and £50,000—had been spent in fitting it up with the most elaborate and improved appliances for electrical treatment. The institution was called the Electropathic and Zander Institute, and although at present with regard to its conduct he (Sir Richard) had nothing to say, it was only fair to state that from the commencement invitations had been given to medical men to come and see what was going on. But the actual methods by which the institute was carried on had not much to do with the question the jury had to try. Quite apart from the electrical treatment that went on in the institution itself, Mr. Harness, a gentleman whose name, no doubt, would be introduced by his learned friend, had invented and been the patentee of a great many electrical appliances, and amongst them, some time ago, he invented what was called Harness's Electropathic Belt. The principle of that belt was this: It was well known that copper and zinc placed in water and brought in contact produced an electric current. The schoolboy experiment or trick, as it was called, of placing copper and zinc on either side of the tongue, and putting them together in order that an electric current might pass, was well-known. Mr. Harness and many other medical gentlemen believed that if you induced a mild, very mild, electrical current to pass through certain parts of the body, they produced a beneficial result. The belt he had been referring to, therefore, consisted of a number of alternate discs of copper and zinc, and the copper and zinc being connected together, the circuit was completed by the moisture from the warm skin. That electric currents did pass through the body there was no question, and if the jury had to consider the matter, he (Sir Richard) would call overwhelming testimony that, whether electricians sneered or not, persons had experienced the greatest benefit from the wearing of the belts. At one time a controversy arose whether the electrical current passed into the body or not. That had, however, been settled beyond doubt. It would be demonstrated that, assuming the belt was worn round the body, the moisture of the skin did supply sufficient effect to make a mild current pass through the surface of the skin or body. He had now to come to the issue to be tried in the present action. Dr. Tibbits had taken great interest in massage and the electrical treatment of disease. He was asked by Mr. Harness to examine his methods and make a report. Dr. Tibbits said he would do so, but he would have to make a number of experiments, and as he was a busy man, he could not do it for nothing. But his report must be taken, whether it was good or bad. Mr. Harness agreed, and undertook to pay the plaintiff a fee of 100 guineas. He was supplied at his own place with some of the belts, and Dr. Tibbits made a number of very careful experiments, extending over many weeks, for the purpose of seeing whether the current would pass through the flesh. He satisfied himself it would, having tried with animals that had recently been killed, and so on. His report showed very remarkable study, and it further showed that an impartial mind was being brought to bear upon the subject. He did not at that time know that other medical men were making independent examination. His report went in, and was published by the Medical Institute in its entirety; certainly no suppression was made with the knowledge of Dr. Tibbits. It was published as the honest opinion of a medical man who had examined into the action of these belts. Dr. Tibbits saw the Zander Institute and the modern appliances for the purpose of administering electricity, and he examined their "case" books and saw most accurate details about persons who went there. He (Sir Richard) did not care whether the persons got any benefit or not—they thought they did. A very large number of persons would depose that their condition had been considerably alleviated, if they were not restored to health. That being so, so far as Dr. Tibbits was concerned the matter might have been at an end. If there was an attack to be made, the attack ought to have been made on the Harness Institute. But that did not satisfy the proprietors of the ELECTRICAL REVIEW who, in that paper, and another called *Science Siftings*, had from beginning to end attempted—if his case was true, unfairly attempted—to prejudice the public mind by statements which were libellous. The learned counsel then referred to what he termed the libel written concerning the plaintiff and published in the ELECTRICAL REVIEW of September 23rd, 1892. It was headed "Electricity and the Medical Profession" and commenced with the words: "There is probably no branch of medical science which is so little understood by practitioners as that which involves the use of electricity for curative purposes. To an expert in electrical science, the extraordinary ignorance which is displayed, even by those who are of acknowledged standing in the medical profession, is a matter for wonderment, and it to a great extent inclines to make one lose faith in the reliability of the profession generally. It is not an uncommon retort when the question is discussed, for medical gentlemen to say, 'You may know something about electricity, but you have never studied medicine, and therefore what can you know about the application of electricity to medical purposes?' This retort would be a just one were the electrical expert to claim that he knew how electricity should be applied for the purpose, but he claims no such thing, he simply asserts, 'You state that an electrical appliance produces an electrical current in a particular manner, when it is perfectly certain that it cannot do this, for the laws of electricity are perfectly definite, and these laws distinctly prove that it cannot do so. We might say a great deal also about the cunning verbiage which reads like the assertion of mighty truths. We are but human, and when ailing most of us are apt to jump at anything which seems likely to afford relief, without being able to exert our reasoning powers which, in time of full health and consequent mental activity, would show the probable, if not certain, absurdity of the claims set forward by the purveyor of the so-called cure. To show want of sympathy with real suffering brands a man as unfeeling; to take advantage of that helplessness to wring money from the sufferer stamps a man as being beneath contempt; yet of such a class are the men who fatten by the sale of useless electrical appliances, and who should be effaced by the strong arm of the law. Much help towards exposing and rendering nugatory the efforts which were daily made to promote the sale of the wares to which we refer might be given by those in authority in the medical profession, if they would signify in some definite way their sense of the conduct of those who in any way ally themselves with the promotion of such electrical appliances." The article then went on to say that no sign being visible, they were compelled to take up the cudgels on behalf of the public. It proceeded, "We have now

before us a pamphlet on the 'Treatment of Disease by the Prolonged Application of Currents of Electricity of Low Power,' by Dr. H. Tibbits, which we consider to be a grave reflection upon the intelligence of the medical profession generally, seeing that Dr. Tibbits is, we believe, supposed to be a recognised authority in the medical world; the pamphlet is nothing more nor less than a direct recognition by Dr. Tibbits of the Harness 'Electropathic Belt' as a valuable electro-medical appliance. In the light of the trial in the Bloomsbury County Court, which we reported in our issue of July 22nd, and in which it was brought out that one of Mr. Harness's qualified medical officers who dealt with cases of hernia was originally a 'furniture salesman,' the reference to the 'qualified officers' in the following letter to Mr. C. B. Harness should be noted." A letter signed by Herbert Tibbits, M.D., F.R.C.P., Edin., &c., from which we extract the following passage, was then set out: "When I first asked you for the electropathic belts to experiment with, I did so with considerable doubt as to their generating electricity; but I am pleased to say that my investigations and experiments have most conclusively proved that they do generate it. I desire to congratulate you upon the very efficient machinery and instruments you possess; and having, during my inspection, been brought into contact with several of your qualified officers and nurses, I can testify to the great value of your institute," &c. The article went on to give the result of Dr. Tibbits's experiments on the Harness belts, which was to the effect that the appliances were valuable and convenient for self-application. It then proceeded: "A perusal of the foregoing by anyone who has a very elementary knowledge of galvanic electricity, and who has one of the Harness belts before him, will at once show that the writer exhibits a most incredible ignorance of electrical laws, an ignorance which utterly unfits him to speak as an authority, and which, in view of the support which it affords for the bolstering up of this appliance, seems to call for an interdiction by the British Medical Association. . . . To get at the public, so as to protect them, is most difficult; the daily Press is, unfortunately, too interested, from an advertisement point of view, to enter into the matter. We are pleased, however, to note that *Science Siftings* has entered the arena to do battle against this imposture. We heartily wish it success, and, although it may take time, we feel little doubt but that perseverance will eventually command it, and that what is undoubtedly a grave scandal, may at last be unveiled in all its grossness, and the promoters and abettors brought to book." He (Sir Richard) might tell them "interdiction" meant the preventing of a man being allowed to carry on his medical practice. If the Medical Council chose, they could remove a man from their rolls, and prevent him carrying on his profession. He called attention to the fact that Dr. Tibbits was charged with almost incredible ignorance of electrical laws—ignorance which it was suggested had been so applied, as to render his "interdiction" desirable. He did not know that anybody was wise enough to say exactly what were the benefits of continuous currents applied to various forms of disease; but not long ago, if it had been suggested that massage (which was in common use) was an effective mode of treatment for certain complaints, hundreds of medical men would have scoffed at the idea. It did not follow, because continuous currents were sneered at from a scientific point of view, that they were useless; in fact, there was an overwhelming amount of testimony that the benefit derived from these belts had been immense. What was the connection between *Science Siftings* and the ELECTRICAL REVIEW? He thought they would find that the proprietors of both papers were the same, and that the same pen which inspired the ELECTRICAL REVIEW had a great deal to do with *Science Siftings*, which was supposed to be independent. That what had been read was a libel there could be no doubt. To charge a professional man with imposture, and to say that he was an abettor of a gross fraud, was calculated to do as much harm to a medical man as could well be imagined. It was particularly hard on Dr. Tibbits, because he was a bankrupt. His bankruptcy, however, had been caused by an enthusiastic (it might be a rash) desire to promote a hospital for the poorer classes, where the processes he had started and developed for the treatment of diseases should be carried out. In conclusion, the learned counsel submitted that in the face of what he should prove Dr. Tibbits knew when he wrote the report in question, to speak of him in the way this libel had done, was a gross and slanderous libel, entitling Dr. Tibbits to very substantial damages.

The plaintiff was then called, and bore out his counsel's opening statement.

Cross-examined by Mr. WALTON: Dr. Tibbits said he was bringing this action for his own benefit exclusively. Mr. Harness was finding the money to carry it on.

And the solicitor acting for you is Mr. Harness's?—No, he is not.

You have been bankrupt, and I think you have never received your discharge?—No.

When Mr. Harness came to you you had not received it?—No.

Did you say in 1891, at the time of your bankruptcy, that for some years your professional income had not exceeded £250?—For fees.

You stated on oath you had never been solvent since 1885, or 1886?—I had not paid my creditors in full, but I had run up no debts.

There was a deed of arrangement in 1885, and bankruptcy in 1891?—Yes.

The West End Hospital—is that a private hospital of your own? No; it is the property of a committee and trustees on behalf of the public. It has now 50 beds. It was built by the public with money I advanced, and for which they never paid me interest.

No private person has had any interest in that hospital in a private capacity?—No.

It would not be true to say it belonged to your wife?—No; that was the West End School of Massage. That had a separate house, but the students were allowed to attend the hospital.

When did you found the School of Massage and Electricity?—In 1886. The committee did not manage the school as well as the hospital.

Why did you tell Dr. Dowse if he did not retire you would bring him before the committee of management?—Because the committee would have discontinued permission to the students to attend the lectures.

How did you come to transfer the school to your wife?—Because it was not etiquette for a physician to carry on a trading business. I do not myself call it a trading business.

When was that?—In November of 1886.

Did you ever suggest in your examination that you had sold the school to your wife because of professional etiquette?—Not that I am aware of; it was one of my reasons.

From 1887 to March, 1891, you received £1,400 for your wife from this school?—It was not all profit.

With regard to this West End Hospital, did you hold an ice carnival in connection with it?—Yes.

How much did you get?—£1,400 profit. I cannot tell you what the gross was. A committee managed it. I should imagine the gross must have been between £4,000 and £5,000—the expenses were enormous.

Have you ever published any account?—It was managed by the committee.

What did you do with the £1,400?—Paid it to the treasurer. The carnival was in March, 1889, and lasted three or four days.

You have managed seven bazaars?—I have been responsible for them, and obtained for the hospital £6,000.

You brought an action against *Nature* for criticising a work of yours on massage?—Yes.

Mr. JUSTICE MATHEW: We are not concerned with that. It is quite enough for us to deal with the criticism in question.

Mr. WALTON: He has been introduced to the jury as a person of considerable eminence. Probably my friend will elicit the result of that action. (Laughter.) Your book got into difficulties, did it not, Dr. Tibbits?

Mr. WALLACE objected.

Mr. WALTON: Is it not the fact that this book has been restrained from further publication?

The PLAINTIFF: No, certainly not. There was a woodcut which I would not take out simply because Messrs. Macmillan claimed it, and I got other publishers to take it up at once. The letter published by Mr. Harness in his pamphlet contained extracts from my book.

You speak of the assistants at the Institute in Oxford Street as being legally qualified men?—Yes; I had been introduced to a gentleman who was said to have qualifications.

Do you read the *Lancet*?—No. (Laughter.) I disapprove of both the *Lancet* and the *British Medical Journal*.

You seem to be rather at conflict with medical authorities. You wrote to Mr. Harness suggesting how your opinions should be printed in the pamphlet, with advertisements of your book at the end. If you were simply an expert to give an impartial and unbiased report for the benefit of the public, why did you trouble about that?—Because my name was appended.

What had the belt got to do with your book?—I was anxious that my book should be sold.

To put it plainly, you were to give Mr. Harness a puff, and he was to give you a puff?—No; most decidedly not.

Do you say this belt will make electricity pass through the body?—This one—not without external connection.

There are none here?—There were in all that I examined.

Mr. JUSTICE MATHEW: All this is very remote. We are not enquiring into how an absent person carries on his business.

Cross-examination continued: The external connection consists of a pin put into a socket?—Yes, and they ought to be in, unless there s internal connection.

Have you seen the pamphlets in which Mr. Harness describes the form in which these connections are to be used?—No, I have not.

Did not you understand that these connections were for the purpose of being used with stationary batteries?—No, I did not. Never heard anything about it. Mr. Harness simply gave me the belt. I have not seen any belt without external connections, but my opinion at present is, that they should all have them.

You say you have no hesitation in saying the electrical appliances of the Institute are preferable to all others. Do I understand you to say the intensity is increased by the multiplicity of these discs?—Off the body, yes.

When the belt is worn, would it make any difference whether you had one cell or twenty?—It increases the quantity, but not the power of penetrating the skin.

Do you say the experiment with the galvanometer, as described in the pamphlet, has the smallest scientific value?—Yes, I do. I adhere to that.

Is it not the fact, that in doing what is described you get the result of a second circuit that is formed?—You get both. The galvanometer is a most delicate instrument.

You get a result which shows the result obtained by the current formed by the insertion of the platinum needle, but it does not show that any current is passing from one pole to the other?—I say it does.

Mr. WALTON: I will put the belt on in order to explain what I mean. I hope the results are not very immediate. (Laughter.)

In reply to further questions, Dr. TIBBITS adhered to his opinion that some current did pass through the body.

Would the experiment I have referred to lead you to say that either quantity or intensity could be obtained?—The intensity refers to the belt when not worn. It was not written to be cross-examined on by a learned counsel in a law case. (Laughter.)

It was written to be published in selected type?—Mr. Harness was going to publish, and I thought it might as well be printed properly.

Is not this rabbit experiment of little or no value?—I don't say so; but that experiment was published since the libel.

Is it not misleading to give people the idea that the belt may be connected for intensity, and the current passed through the body of a rabbit?—I say the important question for the public is whether or not they get any electricity at all, quite independent of dosage, as to which, in the present state of electrical knowledge, nothing has yet been decided.

Have you taken into consideration the medical value of this belt?—I have seen thousands of testimonials, but I only certify as to the electricity passing through the body. I believe Harness's belt to be of value, from examination of the belts, but not of the patients who have been wearing them.

Did you not ask Mr. Harness to afford you an opportunity of seeing the patients?—How could I? They were private patients belonging to other medical men. If you were wearing a belt, and a strange doctor called upon you, would you take off your clothes and show it to him? (Laughter.)

Do you adhere to the opinion you expressed in this book as to galvanic appliances?—No; I have altered it.

Since Mr. Harness has made a convert of you?—If you choose to apply that term to it.

Mr. JUSTICE MATHEW: We are not here to try the belt.

Re-examined by Mr. WALLACE, the plaintiff said his first experiments were with the belt detached from the body. Then he proceeded to see whether the current, instead of going outside, went inside the body. All the moneys he received from the bazaars went to the hospital. He made himself responsible, and the last resulted in a loss of £1,500, which sent him into the Bankruptcy Court. The School of Massage was carried on first at the hospital, and afterwards at a house close by. In the belt he tested all the elements were doing work and generating electricity.

Dr. ARTHUR JOHN HARRIES and Dr. RUSSELL HARRIS were called, and gave it as their opinion that the belts which had been submitted to them generated a current of electricity which, when applied to the body, passed through.

In the course of the evidence of Dr. Harris, Mr. BANKES mentioned that books containing proofs of the evidence of the plaintiff's witnesses had been handed to the jury.

Mr JUSTICE MATHEW (emphatically): That is extremely improper. How did it come about? It is quite enough, if insisted upon, to necessitate the jury being discharged and the trial being re-commenced.

Mr. GERMAINE explained that he had handed over one book merely that they might see a diagram which was being referred to.

Mr. GERMAINE said he had a number of witnesses as to the curative effect of the belt.

Mr. JUSTICE MATHEW did not see the materiality of evidence upon that point.

Mr. WALTON explained that the electrical paper, for which he appeared, had dealt with the subject from a scientific point of view. So far as Dr. Tibbits was concerned, they had said he had associated his name with these inventions, which would not bear the test of scientific examination.

Mr. GERMAINE said the libel went a great deal further than that.

Mr. J. W. WILSON, C.E., said he was the principal of the Engineering School at the Crystal Palace. He was one of the jurors in the Electrical Exhibition of 1892. The belt produced, when coupled up, generated electricity. He had no doubt it would, when placed upon the body, pass through it.

Cross-examined by Mr. BANKES: He wrote to Mr. Harness and asked him to send a belt, as he (witness) thought he would like to see what it was. He wore it some time, and then tested it. Subsequently Mr. Harness obtained a report from him. There could not have been any stream of electricity in the manner suggested in his first testimonial. He supposed he had made a mistake.

The test spoken of is no test at all?—No, I should say not.

Did you not make that test because there was no metallic connections to your belt?—I do not follow you. A metallic connecting cord was not supplied with my belt, but I asked for it.

As supplied it was incapable of producing any electric current?—I suppose so. (Laughter.)

Being an electrician, you connected up the zinc and copper plates and applied the galvanometer?—I applied the galvanometer before that.

Mr. Harness asked you for more particulars?—He asked me to examine seven belts.

And how much did he pay you for that?—Fifty guineas. (Laughter.)

Mr. WALLACE, in re-examination, elicited that the witness had not examined the belts submitted to Dr. Tibbits. Thereupon the learned counsel remarked that he did not think the evidence could be relative to the case.

Mr. JUSTICE MATHEW: That is a large question. (Laughter.)

Mr. HY. F. JOEL, an electrician of over 25 years experience, said he had had about ten of the belts submitted to him. He found that each and every one did generate electricity. He could prove it by experiments in Court. He had tested the electromotive force, the resistance and the quantity of electricity. He had himself worn each one on the body. Beyond all doubt, the greater part of the current must go through the body, as the part that offered the least resistance.

Cross-examined by Mr. BANKES, Mr. JOEL said he was an electrician pure and simple. Any pieces of copper and zinc coupled up and placed in anything that would act as an electrolyte would produce electricity. Some of the belts were connected inside and did not require an external wire. He was told the belt was specially designed to produce a weak current. With six discs you would have a less current than with two. Four discs neutralised each other and the other two gave a resultant current. The most he obtained was $\frac{3}{10}$ths of a milliampère. That was with the C belt applied to his own body in the ordinary conditions.

Mr. S. J. MACKIE, C.E., of 27, Chancery Lane, for 27 years the science correspondent of the *Standard* and other journals, said he had come to the conclusion the belts generated electricity which went through the body. When the belt was on the body he obtained a click from the telephone.

Cross-examined by Mr. BANKES: When coupled up the belt gave 1·4 micro-ampères.

This completed the plaintiff's case, and the Court adjourned.

SECOND DAY.—FEBRUARY 16TH.

Mr. LAWSON WALTON, Q.C., in opening the case for the defendants, said that it was now his task to place before the jury the defendants' answer to the action. It was not unimportant that they should know at the outset who were the gentlemen who accepted the responsibility of this piece of criticism upon a so-called medical appliance. Mr. Alabaster and Mr. Kempe, and Mr. Gatehouse, founded the ELECTRICAL REVIEW some ten years ago. They were all scientific men, and Mr. Gatehouse and Mr. Kempe, who were specially responsible for the article which was impugned, were men of some eminence in a profession which involved a knowledge of electricity. Mr. Kempe was an electrician attached to Her Majesty's Post Office, and Mr. Gatehouse was an electrical engineer who was a pupil of the late Mr. Robert Sabine, and now he carried on his business as a consulting electrical engineer and journalist. So that the defendants who invited the jury to express the opinion that they had exercised fairly their right of criticism, and expressed frankly their opinion and their censure of an appliance sold to the public, and which the public were invited to purchase, were men who could form an opinion of some weight, and who claimed to have formed in this case a perfectly honest, a perfectly dispassionate opinion, and one which he trusted they would hold, fell within the domain of fair criticism. This action was important to the defendants; it was none the less important to the public. The right to think and form an opinion upon, and if necessary to condemn, any one of the various new appliances of science which were seeking a public market, and were apt to impose upon the uninstructed and credulous members of society, was a right which ought not to be lightly invaded. There had been no suggestion of personal malice or sinister motive on the part or the defendants, who had no temptation to travel outside the domain of scientific criticism in dealing with these appliances, and in reflecting upon the persons who were engaged in selling them. The whole attack had been on the appliances—a censure on those who sold the appliances, and on those who made large profits by putting upon the market what these gentlemen (the defendants) honestly thought—and thought for good reasons—to be an utterly worthless article of trade. In his opinion, before Dr. Tibbits lent his name to Mr. Harness in connection with the publication recommending the public to purchase the belt, he ought to have said he confined himself to the mere abstract scientific inquiry whether electricity could be generated by the belt or not. He maintained that the article did not attack the plaintiff, but denounced in the strongest terms the action of Mr. Harness, who must have smarted from head to foot when he read the opinions of the writer. Mr. Harness, however, had not brought the present action.

Sir RICHARD WEBSTER, interposing, said there was an action by Mr. Harness pending.

Mr. LAWSON WALTON, continuing, said Mr. Harness had brought no action with reference to the article in question, but had commenced another action, which the defendants would deal with when it came on for trial. The plaintiff had no real grievance against the defendants, and he (the learned counsel) alleged that the person who had been censured had put forward a medical man, thinking that the jury might show some sympathy for him, and thereby give the real person attacked an admirable advertisement. It would be proved that the belts were sold and worn in the ordinary course, without the outside connection, which was with a view of attaching the appliance to a battery. The wire was sold loose, for attachment or detachment. Not a single member of Mr. Harness's staff had been called to show that the defendants were under a misconception with regard to that. The jury would be asked to come to the conclusion that Dr. Tibbits had ignorantly or negligently attached his name to an opinion which would encourage the sale of the belts. The learned counsel went on to point out that the public were given to understand by the pamphlet that the number of buttons in the belt had the result of intensifying electrical current. The plaintiff had to admit it was a mistake. It was now conceded that if you put on the belt with a single button on each side, you get precisely the same degree of intensity as if you put it on with 50. The material in this case was intensity; quantity was comparatively unimportant. The conclusion the defendants came to was, that Dr. Tibbits was extremely ignorant of the subject on which he was writing, and it was deplorable and reprehensible that a gentleman in his position, who did not understand the matter, should lend himself to this business. There was another matter. They had used in this case Lord Kelvin's, otherwise known as Thomson's, galvanometer, an instrument of remarkable delicacy, which would show an almost infinitesimal current of electricity if that current existed. But it had been used in such a way as not to test the current passing from zinc to copper, but from zinc to the platinum pin inserted. Of course, what should have been done to prevent the independent current being set up, would have been to insert two platinum pins. A dispute in this case was as to the way in which the belts were supplied to Dr. Tibbits. No belt with internal connections had been produced in Court, and the defendants assumed, from what was stated in the pamphlet itself, that the belt Dr. Tibbits examined was one without the outside connection, because there was a sentence that meant that if you attached the poles of the galvanometer to the metals in the belt as worn upon the body, you got deflections. If that were true, if Dr. Tibbits did get deflections

by attaching the poles of the galvanometer to the inside sides of the belt, then there could have been no outside metallic connection. As you went through the pamphlet you found other evidence of Dr. Tibbits's ignorance of the subject he was dealing with as a person whose opinion was to be relied upon by the public, and he (Mr. Lawson) thought that when the jury had heard the evidence, they would have no hesitation in finding a verdict for the defendants.

Lord KELVIN, the President of the Royal Society of London, said he had made a life-long study of electricity. One of Mr. Harness's electropathic belts had been submitted to him for examination.

Sir RICHARD WEBSTER submitted that the belt must be shown to be similar to that given to Dr. Tibbits.

Mr. WALTON urged that it was sufficient that the appliance was obtained from the place indicated in the pamphlet as where such appliances were to be obtained.

Mr. WM. THOMAS ATWOOD BEARE, of Finchley, was interposed to depose to going to the Zander Institute in 1892 and purchasing a belt for five guineas. The belt was the one produced. He took it to the offices of the ELECTRICAL REVIEW. He asked how the electricity was generated.

Sir RICHARD WEBSTER objected to the question on the ground of irrelevancy.

Mr. WALTON submitted that any person who could sell the belt was authorised to explain its operation.

WITNESS was told that electricity was generated by the discs on the belt coming into contact with the body.

Cross-examined: WITNESS said he was a journalist, doing occasional work for the ELECTRICAL REVIEW. All the papers given to him were handed to the proprietors of the ELECTRICAL REVIEW. He never asked what the sockets on the belts were for, but he saw the sockets. He had not seen the internal arrangements of the belts, and knew nothing about them. There were no external wires on the belt.

Re-examined: Absolutely nothing was said to him about outside connections on the belt—there were none. His attention was not called to any directions.

Lord KELVIN was then asked if he had examined the belt. He said that he had, and if worn on the body in its present condition it was not capable of generating any electricity on the body. He had seen a copy of Dr. Tibbits's pamphlet. The word "intensity" was not used in its proper electrical sense. Nothing in the belt could realise the expression that "either intensity or quantity could be obtained." There was no means of coupling up the belt as it was put into his hands. The words implied an impossibility. To connect the belt with a galvanometer, appliances which did not accompany the belt were necessary. If outside connections were on and applied to the galvanometer, you would get no perceptible current because the belt would be short-circuited. There would be an infinitesimal current, but he believed it would be too small to show on the galvanometer. From the description of the experiment it was absolutely certain that the short wires were not connected up. In the third experiment, the current spoken of arose from one formed between the platinum needle and the copper or zinc. A single needle could not tap the current; there must be two needles. He had read the article in the ELECTRICAL REVIEW.

COUNSEL said he was going to ask whether the criticisms were fair.

Mr. JUSTICE MATHEW said the jury must be asked that.

In cross-examination by Sir RICHARD WEBSTER, WITNESS said that what was known as Sir William Thomson's galvanometer was his (Lord Kelvin's) invention. It was an instrument used for testing very mild currents of electricity.

Have you made any experiments to test the currents with the belts?—No, because I perfectly well know what the result would be without making any. (Laughter.)

Were you asked to look at the diagram on page 6?—Yes.

Did not you say, assuming proper connections, that a current would certainly flow through the body, entering the body by the zinc surface and leaving by the copper surface?—Yes, there would certainly be a small current.

Whether enough to deflect a galvanometer you have not tried?—I have not tried.

You are not a medical man, Lord Kelvin; I believe it is the only attainment you do not possess?—I am an M.D.—(loud laughter)—an honorary M.D. of the University of Heidelberg. I have a license to practice, but I have never exercised it.

Sir RICHARD WEBSTER read the printed directions said to be supplied with the belts and asked if they were sufficient to indicate that the discs were to be connected?—WITNESS answered that they would be sufficient for an electrician to gather how the external circuit was to be completed, but not for anybody else.

By Mr. BANKES: If the belt were properly coupled up the strength of the current would vary with the moisture of the skin. In favourable conditions it would be a small fraction of a milliampère.

Mr. BANKES did not know whether Lord Kelvin had noticed it, but Dr. Tibbits stated that he had procured a live rabbit, killed it, and had it skinned, &c. Then to make assurance doubly sure he repeated the experiment with his own body. (Laughter).

Sir RICHARD WEBSTER pointed out that there was really no conflict about the electrical part of the case. It was now admitted on both sides there would be a faint current.

Mr. JUSTICE MATHEW: Yes, a faint current.

Mr. BANKES then proposed to call a number of witnesses who had purchased the belts.

Mr. JUSTICE MATHEW did not see how it was relevant. He pointed out that Mr. Bankes was really attacking the mode in which a business was being carried on.

Mr. BANKES said that their article was solely directed to unconnected belts. They had never doubted that the belt when properly connected up did generate an infinitesimal quantity of electricity. What they objected to was the sale of unconnected belts.

Mr. JUSTICE MATHEW: That is not the impression produced on my mind. You are attacking all the belts sold by Mr. Harness, and denying the therapeutic value of such appliances.

Sir RICHARD WEBSTER: And I am appearing for Dr. Tibbets.

Mr. BANKES said that it was true that Messrs. Harness had a wonderful institute in Oxford Street, but what his clients said was, "You are selling to the public articles that cannot generate electricity at all;" and, therefore, the object was to gild the counterfeit.

Mr. JUSTICE MATHEW: That is not my construction of the article. I do not think the evidence admissible for the purpose of this case.

Mr. BANKES: The evidence would be to show that belts were generally sold at Harness's place, not coupled up, and no directions given about it.

Mr. JUSTICE MATHEW: I will take a note of it.

Mr. T. E. GATEHOUSE, part proprietor of the ELECTRICAL REVIEW, said that neither he nor his partners had any connection with *Science Siftings*. He was a member of the Institution of Electrical Engineers, member of the Societé Internationale des Electriciens, late assistant to the late Sir Charles Wheatstone, and had had a large experience of electrical matters. He could take the sole responsibility of the article in question. His attention was drawn some years ago to these belts, and he wrote about the belt as then sold. Last summer he was asked to examine a belt belonging to Mr. Jeffrey. He did so and reported.

Sir RICHARD WEBSTER objected to a question directed to whether the belt was coupled up or not.

Mr. JUSTICE MATHEW upheld the objection.

WITNESS said he examined the belt and gave evidence in the Bloomsbury County Court. He received the Electropathic and Zander Institute pamphlet for review. It was accompanied with an invitation to visit the Institute. He had no knowledge then of Dr. Tibbits or Mr. Harness, and had no feeling against them. He read the pamphlet and discussed it with Mr. Kempe, and wrote the article, honestly believing what he stated in it. He had experimented with a quantity of these belts, which had been purchased for the purpose. Beare brought the belt he purchased to him, and he (witness) opened the box. He did not see the directions for wearing, although he took out the papers that were in the box. He produced duplicates of all the papers he had received containing directions about the belts. There was no instruction with reference to coupling up the belts.

Mr. JUSTICE MATHEW reiterated that they were dealing with Tibbits and not with Harness.

Sir RICHARD WEBSTER said he would not suggest that the statements as regarded Harness were libellous. He was fighting Dr. Tibbits's battle.

Mr. BANKES asked if Sir Richard would allow him to say to the jury that the system he was attacking was a fraud.

Mr. JUSTICE MATHEW said he would not advise him on the subject.

Examination continued: WITNESS said he had made tests as to the quantity of electricity produced. The quantity depended on the moisture of the skin of the subject, and he found from $\frac{1}{10}$th to $\frac{1}{100}$th of a milliampère. He should say that there were several paths open for the passage of the current—the surface of the skin, the web of the belt, and the underclothing in contact with the body. Perhaps some would pass through the body, but of that he could not be sure. The belt might be coupled up in such a way as to render any effect it might have, if properly used, nugatory.

Cross-examined: The action was being defended solely by the defendants. His original position was that practically no electricity could go through the body. About October, 1892, he began purchasing belts. He did not go to Harness's place. He did not know whether metallic connections were exhibited in Harness's window; none were supplied to him—he had never seen any. Witness explained the working of the Pulvermacher belt, from which he said a current passed to the body.

Mr. HARRY ROBERT KEMPE, one of the defendants, said he had been engaged in the electrical profession 25 years—20 years in the Post Office. He was a member of various societies, and had written standard books on electricity. Mr. Gatehouse was the author of the article complained of, but that gentleman consulted witness. He agreed with what Lord Kelvin said about the experiments described in Harness's pamphlet. He (witness) had tested the belt. When coupled up, and with the body extremely moist, he had obtained a current of $\frac{1}{10}$th of a milliampère. In the ordinary condition it would be $\frac{1}{100}$th to $\frac{1}{500}$th of a milliampère. 2 to 5 milliampères was recognised as the minimum medical dose. After the belt had been worn any time, polarisation would set in, and reduce the current almost to nothing.

Cross-examined by Sir RICHARD WEBSTER: Polarisation would be rubbed off by the action of the body?—No, it would not.

Mr. JAMES SWINBURNE, an electrical engineer whose electrical qualifications Sir Richard Webster said he did not dispute, stated he had seen the pamphlet which the defendants criticised. He thought the statements made by Dr. Tibbits showed he had hardly the most elementary acquaintance with electricity and was therefore incompetent to deal with the subject he wrote about. For instance it was clear he did not understand the elementary principles underlying batteries. That was proved from his remarks in regard to intensity. The pamphlet also demonstrated that the author did not know how to tap a current. From passages in the pamphlet, he would infer that the belt was not coupled inside or out. He agreed with what Lord Kelvin said as to that, entirely. He agreed with Mr. Gatehouse that in respect of these belts the current going through the body was practically non-existent.

Cross-examined by Sir RICHARD WEBSTER: He was never of opinion that no current would pass through the body. He agreed that some current did pass through the skin, but not that the experiments set out in the pamphlet proved it. He did not know of any statement to that effect put forward by a medical man prior to Dr. Tibbits's.

By Mr. LAWSON: There was an indication in the pamphlet not only that Dr. Tibbits was not an electrician, but that the belts did not work—that was to say, that they did not give any current.

(To be continued.)

NOTES.

Ruthin Electric Lighting.—A committee has been appointed to consider the desirability of substituting electric lighting for gas in the streets of Ruthin, Denbigh.

Cable Interruptions.—The South American Cable Company, Limited, announces that its Senegal-Fernando de Noronha cable, which had been interrupted, is now repaired, and that messages can be forwarded to South America by the company's route *viâ* Teneriffe-Noronha.

Fire.—Owing to the destruction by fire of the Literary and Philosophical Society's buildings, at Newcastle-upon-Tyne, the sixth general meeting of the Institution, advertised to be held on Monday last, 13th inst., is postponed until further notice.

Derby Electric Lighting.—The Electric Lighting Committee report that a clerk of the works had been appointed by Messrs. Bramwell & Harris to superintend the erection of the electric lighting premises. The contractors have commenced laying foundations.

St. Pancras Electric Lighting.—We hear that the electricity accounts formed the subject of discussion at the meeting of the West St. Pancras Ratepayers' Association on Tuesday last. There is much grumbling regarding the last increase in the rates.

The New French Telegraph Cable.—The new telegraph cable which the French Government is laying from Marseilles to Tunis, of which we gave some particulars in the REVIEW of the 3rd instant, was successfully landed at Biserta at the end of last week. In the evening experiments in the transmission of messages were made, and they were successful in every way.

Lewes Electric Lighting.—A report is to be made regarding the question of lighting the Town Hall and Brassey Institute with electric light.

Sunderland Electric Lighting.—Regarding our Note of last week, we now learn that Mr. Campbell-Swinton is to be called in to advise as to the carrying out of the powers obtained by the Corporation for lighting certain portions of the town by electricity.

Society of Arts.—On Monday next, February 20th, the fourth Cantor Lecture on "The Practical Measurement of Alternating Electric Currents," will be delivered by Prof. J. A. Fleming. The following is a synopsis of the lecture: —The measurement of alternating current energy.—Alternating current ergmeters; meters for energy: Schallenberger, Thomson, Brillié, Frazer, Ferranti; meters for quantity: Mengarini, Richard, Frazer; watt-hour meters on high tension primary circuits; methods of measuring total output of alternating current stations; efficiency of supply; conclusion.

Bradford Electric Lighting.—At the last Town Council meeting, Ald. Priestman, in moving the adoption of the minutes of the gas and electricity supply committee, said that he had just got the half-yearly statement of his two departments. The gas section showed a profit for the half-year of £2,274, and in the electricity department the profit for the half-year had been £1,089. He also stated that the total amount expended on capital account in connection with the electric supply was £48,568 12s. 11d. They at present owed to the bank £4,308, and on loans £47,291, and they had paid to sinking fund out of revenue £3,198.

Lectures.—A lecture on "Buxton and Electric Lighting," was on Friday last delivered by Mr. C. P. Goode (of Messrs. Hammond & Co.), in the Town Hall.

Professor Stroud, of the Yorkshire College, is delivering a a series of lantern lectures at the Leeds Y. M. C. A., on "The Electric Light."

Belfast Electric Lighting.—The new chief fire brigade station at Belfast is to be lighted by electricity, the work being in the hands of Mr. J. H. Greenhill, who prepared a report on the subject.

The Royal Society.—The following paper was down for reading before this Society last night:—"The Value of th Mechanical Equivalent of Heat, deduced from some Experi ments performed with the view of establishing the Relation between the Electrical and Mechanical Units," by E. H. Griffiths.

The Junior Engineering Society.—At a meeting of this society, held at the Westminster Palace Hotel last Friday, a paper on "The Application of Small Electric Motors" was presented jointly by two members, Mr. Douglas Heap, M.I.Mech.E., and Mr. Arthur Heap, Stud. I.E.E.

Bournemouth Electric Lighting.—At a recent meeting of the Bournemouth Town Council, it was reported that a letter had been received from the Bournemouth and District Electric Supply Company, asking for permission to substitute several underground "chambers" for the present large number of "boxes" containing apparatus for controlling the supply of the electric current in many parts of the town. The matter is receiving consideration.

Dewsbury Electric Lighting.—The site of the old gas works has been adopted for an electric lighting central station.

Llangollen Electric Lighting.—The local authority has formed itself into a committee to consider the lighting of the town by electricity.

Dolgelly Electric Lighting.—An application has been made to the Local Board by a private firm for the sole right of supplying electricity within the area of the board for a term of 21 years. The board have refused to entertain such a proposal.

Obituary.—Mr. Norvin Green, president of the Western Union Telegraph Company, died on 11th inst.

Lambeth Electric Lighting.—The electric lighting committee of the Lambeth Vestry have consulted Mr. W. H. Preece as to the best mode of carrying out the electric lighting order granted by the Board of Trade to the vestry last year. Mr. Preece has presented his report.

Liverpool Overhead Railway.—In the course of his remarks before the shareholders in the Liverpool Overhead Railway Company, Sir Wm. B. Forwood said that they hoped to open the railway to the public on March 1st.

Harrogate Electric Lighting.—The Corporation have requested the Board of Trade to grant them more time to consider the electric lighting question.

Institution of Electrical Engineers.—On Thursday next, February 23rd, Mr. W. M. Mordey will read his paper on "Note on Testing Alternators."

Victoria Embankment Electric Lighting.—At the meeting of the London County Council on Tuesday last it was agreed, on the recommendation of the Parliamentary Committee, that £5,000 extra expenditure be authorised in the Bill which provides for lighting the Victoria Embankment and Gardens, and Westminster and Waterloo Bridges.

Worcester Electric Lighting.—The completion of the purchase of the Powick Mills as a site for a central station has been decided upon. The Watch Committee of the City Council has been empowered to make such arrangements as are desirable in connection with the purchase and the use of the water power at the mills.

Old Students' Association.—The meeting announced for last Wednesday, February 15th, is unavoidably postponed, and will take place on Wednesday, February 22nd, 1893, at Finsbury Technical College, at 7.30 p.m.

Assessors in Patent Actions.—Prof. Forbes is to be congratulated, says *Industries*, on being the first assessor called in under the Act of 1883, more especially as he has been a strong advocate of the advisability of calling in unbiased technical assistance in that way. It is not generally realised that in patent cases either side can demand an assessor, even if the other side does not wish the judge to have that assistance.

Edmonton Workhouse Electric Lighting.—Referring to our previous note in regard to the proposed electric lighting of the Edmonton Workhouses, we now hear that the authorities consider it unwise to at present enter into any scheme for the purpose of lighting the buildings by electricity, as "in a few months certain patent rights in reference to electric lighting will expire, and there is a prospect not only of there being improvements made, but of a considerable reduction being made in the cost of necessary appliances"!

More Reductions in Price per Unit.—The Westminster Electric Supply Corporation give notice that from March 31st next the standard charge for electric energy will be reduced to 6d. per Board of Trade unit, with a sliding scale of rebate to clubs and other large consumers. For current supply for lifts and other motor power, the charge is 5d. per unit.

The London Electric Supply Corporation, announce that from April 1st next, their standard charge for electrical energy will be 6d. per Board of Trade unit. All customers will also be entitled to the benefit of a sliding scale, extending from the standard rate to 5d. per unit, based on their consumption of energy.

Edinburgh Electric Lighting.—The Electric Lighting Committee of Edinburgh Town Council had another meeting last week. At a recent meeting of council, it was pointed out that the system of lighting to be employed, high tension or low tension, depended very largely upon the density of consuming-population within the area of supply, and that one of the first questions to be determined was the number of persons who would be likely to use the electric light within that proposed area. It was this phase of the subject which engaged most attention at last week's meeting. It was proposed that circulars should be sent out in order to ascertain how many people would be disposed to use the new illuminant, but after consideration, it was resolved that nothing of this sort should be done until after consultation with the experts, whose advice is to be taken upon the whole matter.

The Projected Electric Railway in Paris.—The Berlier scheme for an underground electric railway in Paris is about to form the subject of difference between the French Minister of Public Works and the Paris Municipality. The dispute concerns the right of concession attributed to the town in regard to tubular electric tramways and those on the street level. It appears that the Government hardly recognises the right of the town authorities to grant powers for certain kinds of tramways which, they contend, are of the nature of railways, and should be decided by the State.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bristol.—No date stated. Tenders are to be invited for the switchboard and some other fittings required at the central station.

Swindon.—May 1st. For the electric lighting of the district. Further particulars after the 27th inst. from Mr. H. J. Hamp, borough surveyor, Public Offices, Swindon, Wilts.

Craiova (Roumania).—No date. The authorities desire to receive propositions, estimates, &c., for electrically lighting the town. Further particulars from the offices of the Mayoralty, Craiova.

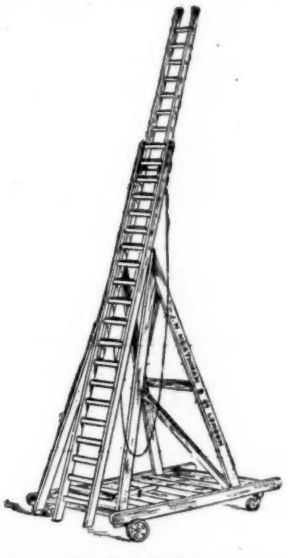
Brussels.—March 3rd. For the supply and fixing of the necessary apparatus for installing a system of electric bells, speaking tubes in various official buildings (Specification 153). Further particulars from the offices of the Provincial Government, Louvain, Brussels.

CLOSED.

Blackpool.—It has been resolved to accept the following tenders:—Messrs. S. and J. Whitehead for the stonework (labour and materials) and brickwork (labour only) required for the proposed electric light station; Mr. Thomas Hartley, for the joiners' work (labour and materials) required for the above; John Kay & Sons, for the slaters' work (labour and materials); Messrs. Worthington and Sons, for the plumbers, painters, and glaziers' work; Messrs. James Allan, sen., & Son, for ornamental cast-iron electric lamp-posts for public electric lighting on the promenade, subject to a sample lamp-post being approved by the committee.

BUSINESS NOTICES, &c.

Ladders for Electric Light.—The illustration shows a portable extension ladder made for the Brighton and also the Victoria Railway Stations, by J. H. Heathman & Co., the well known patent ladder makers, of Endell Street, London. The main ladder is 17 feet 3 inches long, and the extension gives a reach of 32 feet, but can be arrested at any one of its rungs to reach intermediate heights. Being mounted upon four rubber-tyred wheels, one man can manage the whole, and, to pass under gateways, the ladder swings upon trunnions



to a horizontal position. The slide-ladder is easily raised and lowered by means of a rope over pulley, and a quadrant stay at the foot of the main ladder enables it to be pitched and secured at varying angles. The head is fitted with grapnel hooks to take over the cross iron rods of the railway roof, and a portable stand was also provided to hook on any rung, to either give a broad stand for the man or for him to place tools upon. The ladder is used for trimming arc lamps.

Catalogues, Lists, &c.—Messrs. Ludw. Lowe & Co., of Berlin, have sent us separate lists of their planing and slotting machines, presses, and drilling and grinding machines. These, we understand, are advance sheets of a new catalogue which the firm are preparing. In addition to regular machines, Messrs. Lowe are makers of a great variety of special tools which it is impossible to catalogue. The lists are certainly nicely printed and are well worth perusal. The illustrations, of which there are a good number, are very clean. The London agent is Mr. H. F. L. Orcutt, 145, Cannon Street, E.C.

A catalogue, printed in German, has been sent us by Messrs. P. J. Kipp & Zonen, of Delft. The book deals with telephones, batteries, electric bells, switches, and numerous electrical apparatus.

Rochdale Electric Lighting.—Messrs. Cunliffe and Swyre, of Wellfield corn mills, have lately had their works fitted with the electric light, Mr. K. J. Grindod, of Oulder Hill, Rochdale, being the contractor. During the week a powerful search light has been worked from the top of the mill of Messrs. Kelsall and Kemp. Messrs. C. A. Parsons & Co., Newcastle, are fitting 500 incandescent lamps in the mill, of which about 240 are already in use.

Private Electric Lighting.—The contract for electric lighting of Altyre House, Forres, the residence of Sir William Gordon Cumming, Bart., has been placed with Messrs. A. Macleod and Co., electrical engineers, 3, Dundas Street, Glasgow. The installation will be a rather large one. The specifications were prepared by Mr. Wm. A. Bryson, M.I.E.E., under whose supervision the work will be carried out.

Walsall Electric Lighting.—The Walsall Town Council have decided to engage Mr. F. Brown, of Birmingham and Walsall, as consultant in the new electric light scheme, which it is contemplated will cost between £15,000 and £20,000. It is stated that the works will be completed in a little over 12 months, and that for three months after the completion Mr. Brown's services will be retained.

Bergtheil & Young.—This firm have recently completed a very successful organ-blowing plant at the Weigh House Chapel, Oxford Street, and are at present wiring the following premises:—The Entre Rios and Buenos Ayres Railway Company's offices at No. 2, Coleman Street; Nos. 1, 2 and 3, Balfour Place; Messrs. Clarke and Son's premises, Scoresby Street, and Messrs. Robertson and Nicholl's, of 18, Cockspur Street.

Personal.—On Thursday last, the 9th inst., Mr. J. H. Kingstrotte, who for the past seven years has been "foreman" in the instrument department of Messrs. Woodhouse & Rawson (but now leaves to manage the firm of Collier, Marr & Co., electrical engineers, Manchester), was presented with an address and writing-case, the gift of the various workers in his department.

Liverpool Overhead Railway.—We understand that the contract for the station-to-station electric bell signals and the electric bell communications in the cars was placed by the Liverpool Overhead Railway Company with Messrs. Maunsell Mercier & Co., of Deansgate, Manchester.

Aluminium Solder.—Mr. W. Archibald Briggs of East Dock Street, Dundee, who is sole licensee and maker for Great Britain of Richards's patent aluminium solder, has sent us one of his circulars which deals exclusively with the merits of this article.

Ball-Room Electric Lighting.—On the occasion of a ball at the Chelmsford Shire Hall, last week, the hall was lit specially by electricity, the installation being carried out by the Chelmsford Electric Lighting Company.

School Electric Lighting.—The electric lighting installation at Werrington Industrial Boys' School, has been completed to the entire satisfaction of the authorities. The work was carried out by the Electric Construction Corporation.

Dinner.—On Saturday evening last the *employés* of Messrs. Ullathorne & Edmondson, electrical engineers, of Bradford, entertained the principals to dinner at the County Restaurant.

J. E. H. Gordon & Company, Limited.—A petition for the winding up of this company was presented on the 8th inst., and is to be heard before the High Court of Justice on the 20th inst.

Portrush Electric Lighting.—It has been resolved to advertise for tenders for electrically lighting the town.

CITY NOTES.

The General Electric Power and Traction Company, Limited.

THE directors' report, submitted to the shareholders at the second ordinary general meeting held at Winchester House, Old Broad Street, on Tuesday last, 14th inst., reads as follows:—

"The directors beg to submit the accounts of the company up to September 30th, 1892. Some delay has necessarily occurred in the preparation of the balance-sheet and report in consequence of several changes in the executive, and the illness of the chairman and certain members of the staff. The directors have also awaited the preparation of an exhaustive report by the auditors, which accompanies the balance-sheet and gives the fullest information regarding the various items. The anticipations of the directors as expressed in the last report have not been fulfilled, especially with regard to electric traction; the boat season has proved disappointing, owing to the unfavourable state of the weather; but the fleet of launches has been maintained in a high state of efficiency, and the service has given general satisfaction. A steady development of this branch of the business is hoped for. Four launches were engaged on the Manchester Ship Canal throughout the summer, but unless advantageous offers are received for their future employment, the whole of the fleet will be brought to the Thames. With regard to electric traction, the directors regret to report that in consequence of a misunderstanding with the North Metropolitan Tramways Company on account of the unsatisfactory condition of the roads, the service at Barking has been discontinued. Much valuable experience has, however, been gained during the work, and the directors feel confident that under ordinary favourable circumstances this form of traction will finally become a commercial success. Arrangements are now being made for the transfer of the Kentish Town works to Millwall, where water-side premises have been secured and the works necessary for the working of Parker's copper deposition process are nearly completed. The directors anticipate a very profitable business in connection with this work and the manufacture of copper wire. As explained in the auditors' report, nearly the whole of the amount carried to the debit of profit and loss is made up by amounts written off on account of depreciation of stock, plant, machinery, patent rights and goodwill. The volume of business might have been larger, but the directors have steadily declined all business of a speculative character. The vacancy on the staff caused by the retirement of Mr. Robert Macpherson, our late manager, has not yet been filled up. The head office expenses have been much reduced during the latter portion of the year, and every effort of the board is being made to carry on the business with the greatest possible economy. The directors are hopeful that by careful attention to all branches of the business they will be able to present a much more satisfactory report at the end of the current year. Since the last general meeting two of our directors, Mr. Thomas Fuller and Mr. James Paxman, have retired. The board has been strengthened by the addition of Thomas Parker, Esq., M.Inst.C.E. In accordance with the articles of association, two of the directors, the Right Honourable the Earl of Albemarle and Lord Egerton of Tatton, retire, both of whom are eligible and offer themselves for re-election. Messrs. Ward and Wilding, the auditors of the company, retire, and offer themselves for re-election."

TRADING ACCOUNT, from October 1st, 1891, to September 30th, 1892

DR.	£	s.	d.
To Sundry purchases, expenses, and cost of production during the 12 months at Kentish Town Works, Barking, and the several river stations, including amount of stock on hand at September 30th, 1891, as reduced	36,704	7	8
	£36,704	7	8

CR.	£	s.	d.
By Sundry sales and work executed during the 12 months, including hire and charging of launches, and amount of stock in hand, as at September 30th, 1892	32,695	3	9
„ Balance carried to profit and loss account ...	4,009	3	11
	£36,704	7	8

PROFIT AND LOSS ACCOUNT from October 1st, 1891, to September 30th, 1892.

DR.	£	s.	d.
To Balance from trading account	4,009	3	11
„ Head office expenses	5,549	17	5
„ Sundry amounts written off during the 12 months for estimated depreciation on plant, machinery, &c., maintenance and depreciation of Barking plant and installation, and generally	39,871	12	10
„ Amount written off patents and patent rights, goodwill, &c.	20,000	0	0
	£69,430	14	2

CR.	£	s.	d.
By Transfer fees, discount and premiums from apprentices, compensation, &c....	148	17	10
„ Amount carried to balance-sheet	69,281	16	4
	£69,430	14	2

BALANCE SHEET, September 30th, 1892.

DR.	£	s.	d.
To Capital—Authorised issue of 35,000 shares of £10 each, as follows:—10,000 preference shares of £10 each, £100,000; 25,000 ordinary shares of £10 each, £250,000 = £350,000; *less* 1,408 ordinary shares not yet issued, £14,080; £2 per share on 9,844 preference shares not yet called up, £19,688; calls unpaid, £6,544 18s. 5d. = £40,312 18s. 5d.	309,687	1	7
„ Sundry creditors—On open accounts, £5,044 16s. 1d.; on bills payable, £2,445 12s. 6d.; on directors' fees, £862 10s.; on suspense account, £895 15s. 11d.	9,248	14	6
„ Contingent liabilities on disputed accounts, *re* Barking maintenance, &c., about £850.			
	£318,935	16	1

CR.	£	s.	d.
By Capital expenditure—For purchases of the businesses of the Electric Traction Company, Limited, and Messrs. Immisch & Co. (including all plant, machinery, trade and other fixtures and fittings, launches, boats, charging stations, and all patents and patent rights, &c., &c.), as per last balance-sheet, £246,660 18s.; *add* additional expenditure during the year as follows—On account of purchase of patent for depositing copper (being part of £20,000 agreed price), £10,000; on account of building of works at Millwall for same (under contract for £4,200), £1,500 = £258,160 18s.; *less* amount written off during the year for estimated depreciation, after providing for sundry additions, &c., during the same period (including			

	£	s.	d.
amount written off, book value of patents, patent rights, goodwill, &c.), £38,896 5s. 8d. ...	219,264	12	4
By Sundry debtors, £8,425 1s. 2d.; *less* reserve to cover bad and doubtful debts, £2,766 11s. ...	5,658	10	2
„ Stock on hand as per inventories	14,374	17	10
„ Rents and insurances paid during the year, but unexpired at this date	273	13	9
„ Bills receivable in hand	10,468	5	1
„ Cash in hand and at bank	596	16	11
„ Profit and loss—Net loss during 12 months as per profit and loss account, £69,281 16s. 4d.; *deduct* profit brought forward as per last balance-sheet, £2,475 6s 1d; *less* dividends on preference shares paid during the year, £1,492 9s. 9d. = £982 16s. 4d.	68,299	0	0
	£318,935	16	1

We have examined the above balance-sheet with the books and vouchers of the company, and certify the same correct and in accordance therewith, subject to our report.

WARD & WILDING, *Chartered Accountants.*

January 27th, 1893.

The second ordinary general meeting of the shareholders of the above company was held on Tuesday last at Winchester House, Old Broad Street, the Earl of Albemarle (the chairman) presiding.

Mr. J. PAYNE (the secretary) having read the notice convening the meeting,

Mr. J. PENDER said that at the last adjourned meeting, over which he had the honour to preside, he made a statement that the cause of the delay in the rendering of accounts was that one of their secretaries had been drowned, and that the other had gone off his head. He had since learned that that was not exactly the case, and that the remarks he made as regarded the latter gentleman were incorrect. Naturally that gentleman felt rather grieved and pained, and therefore he, Mr. Pender, begged to inform the meeting that the real cause of that gentleman's absence from business was over-anxiety and overwork in connection with the company.

The report and accounts having been taken as read,

The CHAIRMAN, in proposing their adoption, said: Gentlemen, I am not going to make a great many remarks. I regret that it has been necessary to postpone this meeting so often, but it is well known to you all, I think, that very grave and serious changes have been made in our staff, and that many of those who take the liveliest interest in our affairs have been absent through illness. One of our directors is at present absent, through illness, in the south of France, and I have received a telegram from him to-day stating his agreement with what I shall lay before you as the course we are going to pursue, and giving his full concurrence thereto. I, myself, have been suffering for the last two years from a very serious illness, and have not been able to give that attention which, for many years previous, I gave to electric traction work. And it was therefore owing to the many changes that have taken place in our managerial staff, that we all felt that it was necessary to have a most thorough investigation of our affairs, and the report in your hands gives a history of the company in a very complete form—so complete that I do not think I need say much concerning it. It will be observed that the losses which are mentioned in this report are not due to the operations of the present year only—they are the outcome of former proceedings. It will be old history to you to refer in any way to the history of electric traction. It is only three years since this company began its operations, but many persons have been thoroughly devoted to electric traction for a much longer period than that. It will be observed that the sum of nearly £60,000 has been written off the capital account in respect to the depreciation of plant for the Barking undertaking, and the patents and goodwill have been written down by £20,000. Now, the shareholders may possibly imagine that the writing down of these amounts would deprive them of some of their money. But that is not so. The relative value of the property of the shareholders will remain exactly the same, though their nominal value will be depreciated; but if we are right in believing, as we all do believe, that a better time is coming for us, as we are all treated in exactly the same way, we shall all share alike in any advantage that may accrue in consequence of the improvement. These are losses regarding which the directors thought it should be plainly recognised by the shareholders that they are losses in no way due to the management. Coming next to the trading accounts, you will see that it shows a loss of £4,000, but that has arisen largely from exceptional causes, and the directors hope that they will not occur again. The expenses of management may also appear high, but the greater portion of those items were incurred in the early part of the year, and lately very considerable economies have been introduced. We have made an arrangement by which the Electric Construction Corporation will for one year undertake the management of the company for a fixed sum, which represents less than one-tenth of the amount charged for the expenses of the past year. That, you will see, means a very large diminution in your expenditure. And when I am talking of lessening the expenditure, though the directors' fees appear upon the balance-sheet, you will be happy to hear that for the last nine months the directors have not received anything at all, and the nominal indebtedness which they still retain upon the company is calculated at about half of the original amount. So that you can see there has been no selfishness on the part of the directors. The Electric Construction Corporation, as a result of the changes which they are making in their organisation, will be able, with the directors' help, to arrange for the efficient conduct of this company's business, and the directors will, in consultation with them, devise a plan of action for the future which will, they hope, be beneficial to the shareholders. The Electric Construction Corporation are large shareholders in the company, and therefore they are very interested in its welfare. With regard to electric traction, not much progress has been made, but we are confident that the system which we advocate would be of the greatest possible benefit to the shareholders, though they are at the present time in abeyance. We are bound to admit that the views we entertained in connection with this branch of our business have been hardly fulfilled. We have had promises from various quarters, and we have incurred considerable expense to demonstrate the advantages of electric traction as compared with the present system. We have seen no reason to change our opinions, but whether it is a want of confidence, or want of enterprise, or want of capital or vested interests, which are always so powerful, or ignorance on the part of the public as to the advantages of electric traction, the experiments have not been a success commercially, and we do not feel ourselves justified in continuing to demonstrate at our own cost, what should be obvious to those entrusted with the management of our tramway system. We had at one time a very amicable arrangement with the North Metropolitan Tramway Company. We worked a part of their system. I am now going into a little bit of ancient history not connected with this company—we were able, by a long series of experiments, to show the North Metropolitan Tramway Company that there would be considerable advantage in adopting electricity on their lines. They saw our experimental installations, and they were so pleased that they went to Parliament to acquire the right to use electricity over their whole line. Parliament, it its wisdom, introduced a clause by which, while allowing the tramway company to carry electricity over their line, put in a clause that the corporation owning the land should have a veto by which they might cause the line to be removed in 24 hours. The North Metropolitan Tramway Company were very kind to us, and they co-operated with us in every way, but when they found that they were absolutely at the mercy of the corporation of the land over which they ran, they came to the conclusion that it would never do for them to make the necessary capital expenditure to run their trams by electricity, and also the price at which we were working, though it was all very well as an experiment, was not sufficient to be commercially satisfactory. The consequence was, that when the tramway companies found that the electricity would not be continued, the road got very much neglected, which caused many accidents, and involved the company in considerable expense. But that has not changed our opinion that the principle of running cars at a mileage rate is altogether unfair to electric traction. Under that system, the greater the success, the greater the loss to those who had to provide the electrical energy. It was notorious that the cars at Barking were very much overloaded, but of course in such cases the police are not required to interfere. We have, in the course of that experiment, gained some valuable experience, and I am advised that, given an installation of, say a dozen cars, on the average gross receipts of 11d. per car mile, which is much less than the receipts at Barking, the installation could be run at a profit to all parties concerned. This is certainly my opinion, and I believe it is the opinion of my co-directors. The vested interests involved must naturally tend to retard the introduction of electric traction, but the time must come when this system will be used throughout the country, and when that time comes we ought to have our share of the benefits. There is no doubt, in anticipation of the greater demand for machinery than has been experienced, our late manager produced more stock than was strictly prudent, and acting upon the advice of our auditors, we have thought it prudent to write down the stock to what we consider an extremely low figure. The expenses in other branches of the company have been kept down as low as possible, and the losses of the year have been very materially reduced. Now I am coming to a point which, I think, gives us more than a gleam of hope. At the present moment our attention is devoted to the completion of our copper works at Millwall. Mr. Thomas Parker has joined our board, and he understands that particular branch of the business, and if properly worked, he says there is every reason to hope that this copper work will form a most important branch of our business. If we determine to turn this copper into wire, we do not anticipate that there will be any difficulty in finding a market for all we could manufacture. The Kentish Town works will be transferred to Millwall entirely—in fact they hardly exist any longer—and considerable saving will be effected by the removal. I now move the adoption of the report and accounts.

Mr. J. PENDER seconded the motion.

Mr. DUNN said he could hardly reconcile the statement of the chairmain that the losses on the capital would entail no losses on the shareholders. Seeing that 20 per cent. of the capital had been lost, he did not see how the shareholders could help feeling it. In his, Mr. Dunn's opinion, the proper course would be to write down the capital. He proposed that a committee of shareholders should be appointed to confer with the board with regard to the organisation of the company.

Mr. THOMAS seconded the amendment.

Sir HENRY MANCE pointed out that the various items had been written down very largely in accordance with the advice of the auditors, for the board thought that it was better that things should stand in the books at their approximate value. Of course, if they had been written down too low, nothing would be lost to the shareholders. As soon as the directors saw that the year was not likely to be such a good one as they hoped, they first of all reduced their fees, and subsequently they had not taken even the reduced amounts. As far as he, the speaker, was personally concerned, he did not intend to take his fees; but the shareholders could hardly expect gentlemen to give up their time to manage the affairs of the company without remuneration. With regard to the suggested conference, he did not see what good effect it could possibly have. The directors had given the shareholders every possible information, and, as they had heard

steps had been taken to reduce the expenditure very much, and to insure the management in the future being thoroughly efficient. One step was the strengthening of the board by adding Mr. Parker to it, who would be able to devote his attention to the finding of copper, for which they all hoped so much. Undoubtedly the capital would have to be reduced, but it was premature at the present time to take such a step, because it had not been ascertained what figure it should be reduced to.

The CHAIRMAN, in answering the shareholders, said that the directors had great hopes that the launch business of the company would be the satisfactory part of their business in the future, as there was every probability that all their launches would be called into the Thames.

Mr. DUNN's amendment having been negatived, the report was unanimously agreed to.

The two retiring directors, the Earl of Albemarle and Lord Egerton of Tatton, having been re-elected, a similar motion was agreed to with respect to Messrs. Ward & Wilding, the auditors, and the proceedings closed with a vote of thanks to the chairman for presiding.

Westminster Electric Supply Corporation, Limited.

THE directors report reads as follows:—

"The board of directors, in presenting their report and accounts for the year 1892, are gratified in being able to state that the business of the Corporation continues to make steady and satisfactory progress. After very careful consideration, the directors decided from July 1st., 1892, to reduce the price of current from 8d. to 7d. per unit. The policy of reducing the standard charge which this Corporation initiated, has been fully justified by the increased consumption of current. On December 31st, 1891, electric energy was being supplied from the Corporation's mains to the equivalent of 62,820 lamps of 8 C.P., and the supply increased to 98,686 on December 31st, 1892. At the present time there are on circuit the equivalent of 102,743 lamps of 8 C.P., and applications have been received for a further 8,229. The total length of roadway along which mains have been laid exceeds 33 miles, making about 130 miles of ways into which upwards of 97 miles of copper (strip and cable) have been drawn. The plant and machinery have been working satisfactorily throughout the year. Since the last meeting of shareholders the building at Davies Street has been completed, the frontage having been finished as shops and chambers. In September last the chief office was transferred to Eccleston Place on the completion of the buildings there. Great convenience has been experienced by the concentration of the general staff under one roof. As promised at the last meeting, the directors offered £40,600 in £100 4½ per cent. mortgage debentures to the shareholders, by whom the issue was immediately taken up. The directors were pleased to be able to pay a first dividend at the rate of 3 per cent. for the half-year ending June 30th last. The accounts now show a balance of £7,324 8s. 9d. to the credit of net revenue, and they recommend the payment of a dividend at the rate of 4 per cent. for the past half year, carrying forward a balance of £1,324 8s. 9d. In accordance with the articles of association two of the directors, Messrs. J. Browne Martin and R. W. Wallace retire, but being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers & Co., also retire, but, being eligible, offer themselves for re-election."

ABSTRACT OF ACCOUNTS to December 31st, 1892.

CAPITAL ACCOUNT.

Dr.	£	s.	d.
To Expenditure per last account	297,640	17	9
„ Further expenditure to December 31st, 1892	53,556	2	1
„ Balance of capital account	18,803	0	2
	£370,000	0	0

Cr.	£	s.	d.
By Ordinary shares, 59,900 £5	299,500	0	0
„ Founders', 100 £5	500	0	0
„ Debentures, 700 mortgage	70,000	0	0
	£370,000	0	0

REVENUE ACCOUNT.

Dr.	£	s.	d.
To Generation of electricity	13,621	19	1
„ Distribution of electricity	1,331	17	6
„ Proportion of rents, rates and taxes	2,364	9	2
„ „ of management expenses	3,975	11	2
„ „ of law and Parliamentary charges	355	2	5
„ Depreciation	2,900	0	0
„ Special charges	285	5	6
„ Balance to net revenue account	11,608	10	2
	£36,442	15	0

Cr.	£	s.	d.
By Sale of current per meter	33,499	8	6
„ „ „ under contract	1,455	4	0
„ Rental of meters, converters, &c.	1,431	5	0
„ Transfer fees	56	17	6
	£36,442	15	0

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To Interest on mortgage debentures	1,950	6	1
„ Amount allowed for bad debts	197	12	11
„ Depreciation on furniture, &c.	61	0	0
„ Amounts written off: Preliminary expenses account £1,000, Patent Law charges £210	1,210	0	0
Balance to general balance-sheet	11,816	2	4
	£15,235	1	4

Cr.	£	s.	d.
By Balance from account	3,159	14	3
„ „ „ revenue account	11,608	10	2
„ Interest on temporary deposits	135	16	11
„ Rents paid and accrued	331	0	0
	£15,235	1	4

GENERAL BALANCE SHEET.

Dr.	£	s.	d.
To Capital account	370,000	0	0
„ Sundry creditors on open accounts	2,963	0	0
„ Sinking fund account	812	0	0
„ Net revenue account, balance at credit thereof	7,324	8	9
„ Depreciation account	3,530	0	0
„ Unclaimed dividends	24	17	1
„ Debenture interest (accrued)	716	12	6
	£385,370	18	4

Cr.	£	s.	d.
By Capital account	351,196	19	10
„ Cash at bankers and on deposit	9,520	13	9
„ Sundry debtors for current	13,405	11	4
„ Stores on hand	607	5	3
„ Deposits with vestries, &c.	294	16	7
„ Preliminary expenses and suspense account, less amount written off	8,450	2	7
„ Patents and law charges account less amount written off	1,895	9	0
	£385,370	18	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, &c.

Year ending December 31st, 1892.

Board of Trade units generated.	Quantity utilised.			Quantity expended in distribution.			Total quantity accounted for.	Quantity unaccounted for.	No. of lamps on circuit. Dec. 31st. 1892.
	Sold to consumers.	Used on works for lighting, meter testing, &c.	Total.	In batteries.	In feeders.	Total.			
1,477,131	1,217,871	45,695	1,263,566	20,810	146,065	166,875	1,430,441	46,690	98,686 of 8 C.P.

(Signed) ALEX. B. W. KENNEDY,
Engineer-in-Chief.

The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

THE twenty-ninth ordinary general meeting of this company was held on Tuesday, at the Cannon Street Hotel, Mr. S. W. SILVER (chairman) presiding.

The CHAIRMAN called upon the secretary (Mr. W. J. Tyler) to read the notice of the meeting, after which the report was taken as read.

The CHAIRMAN said: The report is a very brief one, but I hope you agree with me that it is satisfactory, as it confirms the hopes expressed when we last had the pleasure of meeting. The result of the year's transactions, after carrying to reserve all the premium on the new capital issued, with a portion of the profit made, justifies our recommending the same dividend as heretofore and a bonus, and carrying forward an amount fully as large as a year ago. The additional capital has been well employed. It has enabled us from time to time to lay in a large stock of raw material under favourable circumstances, and thus to compete successfully in the hard-fought battle of trade, finding remunerative employment for our works, which, I am happy to say, are in a highly efficient condition. We have manufactured over 3,000 miles of submarine telegraph cable, and I am glad to say without a fault and well within the contract time. The same may be said of the French factories; they have been doing good work with the sinews of war in the form of ample capital, and the masterful attention of my friend, our managing director, in command. I have no fear as to the future of this undertaking. I have much pleasure in recommending to your adoption "That the report and accounts now presented be received and adopted, and that the dividend of 5 per cent. and a bonus of 2½ per cent., together 15s., free of income tax, and payable on the 15th inst., be now declared."

Mr. ROBERT HENDERSON (a director) seconded the motion of the chairman.

The CHAIRMAN: I shall be glad to hear any observations any gentleman may wish to make.

There being no remarks, the CHAIRMAN said: More or less I suppose we are business men here, and we have not much time to spare. If there are no observations to make, I will put it that those who are in favour will be kind enough to hold up their hands. (This was done.) On the contrary? I declare it to be unanimously carried.

Mr. MATTHEW GRAY (managing director) proposed the re-election of Mr. Silver, as chairman, and the Hon. Henry Marsham as director of the company.

Mr. ABRAHAM SCOTT (a director) observed that the business and works were so well and ably managed, that he would be sorry if both Mr. Silver and the Hon. H. Marsham were not on the board.

Mr. GRAY then put the motion, which was adopted *nem. con.*

The CHAIRMAN: Well, gentlemen, I thank you for this renewal of your confidence. I need hardly say that it will stimulate us to fresh exertions, and hope that we shall meet under as favourable circumstances on the next occasion.

Mr. MARTINDALE moved that Mr. Clarke, in place of Mr. J. Weise who retires, should be elected auditor for the current year with a fee of 30 guineas.

Mr. COCHRAN seconded the motion, which was adopted without any dissentient.

Mr. G. HANBURY thought they ought not to separate without passing a vote of confidence in, and thanks to, the directors for the manner in which they had conducted the affairs of the company. The investment was steady and excellent, and he begged to propose the vote mentioned.

Mr. TREBLE seconded this, and,

The CHAIRMAN, in reply, said: Well, gentlemen, it remains for me only to thank you for this fresh proof of your confidence. In doing so, I will but remind you that with the stake on this side, our interests and yours are identical.

The proceedings then terminated.

Newcastle and District Electric Lighting Company, Limited.

THE directors' report reads as follows:—"The directors have pleasure in reporting that the supply of current continues to give satisfaction to the company's consumers, and, although the present depression in trade has had the effect of somewhat crippling progress, the prospects of the company continue satisfactory. The installations connected to the company's mains during the year are equal to 3,500 10-candle-power lamps, bringing the total up to about 14,500, and 290,469 units of electrical energy have been supplied, as against 206,017 units supplied in 1891. During the past year 3,012 yards of main and branch piping have been laid, together with 6,146 yards of main and branch cable. A tunnel has now been completed from the company's works to the River Tyne, and condensing plant is being erected to which water will be circulated direct from the river; it is expected that this plant will be in operation next month, and your directors anticipate a considerable saving of both fuel and water. It is anticipated that there will be a great fall in the price of lamps during this year, which will greatly tend to further the interests of the company. The gross earnings during the year amount to £2,139 15s. 1d., and after paying interest and making provision for reserve fund, and writing off £59 7s. 7d. from formation expenses, your directors are able to recommend a dividend at the rate of 3 per cent. for the half-year ending December 31st (less income tax), which together with the interim dividend paid in July last, makes the dividend 5½ per cent. for the year. Sir Benjamin C. Browne retires by rotation, but is eligible, and offers himself for re-election as a director. The auditors, Messrs. Strachan & Co., also offer themselves for re-election."

BALANCE SHEET, December 31st, 1892.

	£	s.	d.
To Capital—5,000 shares at £10 each	50,000	0	0
„ 3,535 shares, £8 called up, £28,280; add calls paid in advance, £200; less calls unpaid, £240 ...	28,240	0	0
„ Creditors, £905 13s. 11d.; loans, £5,000; bankers, £4,285 10s. 8d.	10,191	4	7
„ Reserve fund for depreciation, &c.	1,400	0	0
„ Profit and loss account, balance from last year, £43 7s. 3d.; profit for year ending December 31st, 1892, £1,391 4s. 9d.; less interim dividend, £563 14s. 8d.	870	17	4
	£40,702	1	11

	£	s.	d.
By Amount expended to date on buildings and plant, pipes and cables (including cost of laying), meters, transformers, electrical instruments, &c.	36,315	14	4
„ Office furniture	141	4	2
„ Stock of stores, &c.	139	15	6
„ Cost of license, provisional order, &c.	501	16	10
„ Formation expenses, £859 7s. 7d.; less amount written off, £59 7s. 7d.	800	0	0
„ Debtors (less reserve for discounts £200)	2,788	17	0
„ Cash in hand	14	14	1
	£40,702	1	11

PROFIT AND LOSS ACCOUNT for the Year ending December 31st, 1892.

	£	s.	d.
To Wages, salaries, rent, rates, taxes, and directors' fees	1,549	5	9
„ Stationery and office expenses...	132	17	10
„ Stores, fuel, water, &c.	1,818	8	1
„ Repairs and renewals	275	13	3
„ Balance carried down	2,139	15	1
	£5,916	0	0

	£	s.	d.
„ Interest	239	2	9
„ Proportion of formation expenses written off ...	59	7	7
„ Transferred to reserve fund for depreciation, &c. ...	450	0	0
„ Balance carried to balance-sheet	1,391	4	9
	£2,139	15	1

	£	s.	d.
By Electric energy supplied, less discounts	5,627	8	6
„ Meter and transformer rent	288	11	6
	£5,916	0	0

	£	s.	d.
By Balance brought down	2,139	15	1

Audited and certified, (Signed) STRACHAN & Co., *Auditors.*

The annual meeting of the shareholders was held at the offices of Messrs. Leadbitter & Harvey, 57, Westgate Road, Newcastle, last Monday, Mr. John D. Milburn, chairman of the company, presiding.

The CHAIRMAN, in moving the adoption of the report, said: The leading feature of our present year's work is the payment of a little more dividend. This increase in the earning power is trifling, but it marks progress. A local newspaper stated a month or two ago that the electric lighting companies were not booming. Well, if they were not, it would not be the fault of the companies, which are ready and anxious to meet to the fullest extent whatever public demands there may be. Electric lighting has got over its initial stage, and the directors of the companies are arriving at a fair understanding of its technicalities. To make, however, electric lighting a great success one thing is necessary, and that is cheapness. The following figures will perhaps prove interesting to our newspaper friends, and prove the steady progress we are making:—Units sold, 1891, 206,017; in 1892, 290,469; increase, 84,452. Increase of output, 41 per cent.; increase in receipts, 23 per cent.; selling price, 1891, 5·309; selling price, 1892, 4·650; difference per unit, 0·659; cost price, 1891, 3·420; cost price, 1892, 3·113; difference per unit, 0·307. You will see, therefore, that whilst our average price has been gradually reduced, the cost has likewise been reduced, and by the introduction of the shaft and tunnelling to the Tyne and the new condenser, by which superheated steam is used, the cost of fuel is expected to come down to nearly one-half. This is a great economy, but nothing like the saving which will ensue by doubling the production of the current. In the summer months, when our output is only about 11,000 units per month, the cost of production is about 4½d. per unit. In mid-winter, when the output is 50,000 units, the price per unit comes down to 2d. It is obvious, therefore, that when we shall be able to supply 50,000 units per month, the average cost will be enormously reduced, and we hope at no distant date to be able to produce electric current at a nett cost of 1d. to 1½d. After making some further lengthy remarks he moved the adoption of the report, and this having been seconded by Sir B. C. Browne, and carried, the meeting closed.

Liverpool Overhead Railway Company.—The ninth half-yearly general meeting was held last Tuesday at Liverpool. Sir William Forwood, the chairman, in moving the adoption of the report, said they were now busy completing the electric signals. This was causing the delay in opening. They were running trains daily for the purpose of training the staff, and hoped to throw the system open to the public on March 1st. He referred to various rumours that had been current as to danger to the public from the electric conductors, and said they were entirely without foundation. He prophesied a prosperous career for the railway.

Electricity Supply Corporation.—We have received a copy of the directors' report and accounts, along with a request that we will not publish them until after the meeting, which is to be held to-morrow. We shall, therefore, give them in our next issue. The dividend recommended is 5 per cent. for the year.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 12th, 1893, amounted to £952; week ending February 14th, 1892, £881; increase £71; total receipts for half-year, 1893, £5,862; corresponding period, 1892, £5,033; increase £829.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 10th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,616.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.*	Closing Quotation, February 9th.	Closing Quotation February 16th.	Business done during week ended February 16th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	54 — 55	53½ - 54½xd	54½	54⅛
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	96½ - 97½	95 — 96 xd	96	95½
2,876,140*l*	Do. do. Deferred	Stock	12⅝ - 13¼	13¼ - 13⅝	13⅛	13⅛
130,000	Brazilian Submarine Telegraph, Limited	10	11¼ - 11⅝	11¼ - 11⅝	11⅝	11½
34,600*l*	Do. do. 5 p. c. Bonds	100	99 —102	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛ - 3⅜	3⅛ - 3⅜	3 5/16	3 3/16
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅜ - 2⅝	2⅛ - 2⅛	2 7/16	2⅜
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	104 —106	104 —106	105½	105
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
600,000*l*	City and South London Railway	Stock	37 — 39	37 — 39xd	38	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	12½ - 13	12½ - 13	13⅛	12½
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	7⅞ - 8¼	8 - 8½	8 7/16	8 3/16
$7,716,000	Commercial Cable, Capital Stock	$100	175 — 180	175 —180	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 — 5/16	3/16 — 5/16	¼	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	12 — 13	12 — 13	...	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	18½	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2 — 3	2½ — 3½	3	2⅞
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ - 12	11⅜ - 12	12	11 13/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞ - 15	14⅞ - 15⅛	15 1/16	14 13/16
70,000	Do. 6 p. c. Preference	10	15½ - 16½	15½ - 16	15⅝	15½
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 - 109	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock ...	Stock	111 -114	112 —115	114	112½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞ — 15⅛	15⅛ - 15⅜	15¼	15
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 —112	109 —112	...	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	101½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3 — 3½	3½ - 4	3⅜	3 1/16
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	...	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ⅛	⅛ — ⅛	7/16	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	¼ — ½	¼ — ½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 9⅞	9⅜ — 9⅞	9⅞	9 11/16
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	15⅛ - 15⅜	15⅜	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜ — 19¼	19 —19½	19⅜	19
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	107½	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½ — 7½	6½ — 7½	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22½ — 23½	22½ - 23½	23¼	22 13/16
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	43 — 45	43 — 45	44½	44
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3¼	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	..
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4 — 4¼	4 — 4¼	4⅛	4 1/16
10,000	Do. do. fully paid	5	5⅜ — 6	5⅜ — 6	6	5⅝
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	108 —111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½ — 7	6½ — 6¾	...	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	104	103
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	5⅛ — 5½	5⅛ — 5½	5 7/16	5 3/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½ — 15½	14½ - 15½	15 1/16	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13⅜ — 14½	13⅜ — 14½	14⅛	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4⅜ — 4⅝	4⅜ — 4⅝	4 1/16	4½
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —115	112 —115	114⅜	114¼
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5½ — 6½	5½ — 6½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	½ — ¾	½ — ¾	...	...
11,802	Reuter's Limited	8	7½ — 8½	7½ — 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅝ — 8¼	8 — 8½	8 7/16	8
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8½	8½
3,381	Submarine Cables Trust	Cert.	119 —124	119 —124	...	...
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	3 — 3½	3 — 3½	3⅜	3 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	36 — 40	38 — 42	40	38½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	102¼	102⅛
58,000	United River Plate Telephone, Limited	5	2½ — 3	2½ — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	7¼	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	102 —105	102 —105	102½	...
130,000	West Coast of America Telegraph, Limited	10	2½ — 3½	2½ - 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7⅞ — 8¼	7⅞ - 8¼	8⅛	7⅞
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5⅞ — 6¼	5⅞ - 6¼	6 1/16	6
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅞ - 2¼	1⅞ - 2¼	2¼	...
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	105 —108	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	105 —108	107½	107
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1½ - 1⅝	1 11/16	1½
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10½ — 11	10⅜ - 11	11	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ — 9½	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	106 —109	...	...
$1,136,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	121⅛	...
173,000*l*	Do. do. 6 p. c. Sterling Bonds	100	103 —106	103 —106	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅝ — 6¼	5⅜ — 6	6⅛	5⅞

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. Bank rate of discount, 2½ per cent. (January 26th, 1893.

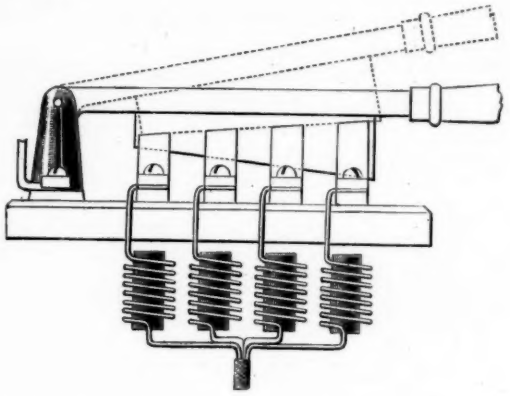
LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅞.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1½—2½.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—Elmore Foreign and Colonial Copper, Founders shares, 6¾—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1⅛—2⅛.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6⅛.—Liverpool Electric Supply Shares of £5 (fully paid), 5⅞—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Debentures, 101—103.—Woodhouse and Rawson £5 Preference (fully paid), ⅞—1⅛.

* Unless otherwise stated all shares are fully paid.

THE THOMSON MULTIPLE CONTACT SWITCH.*

THE difficulty of constructing a multiple contact switch for heavy currents in such a manner that the break shall be absolutely simultaneous at all points is well-known. It is also evident that if the breaks are successive, though the intervals be exceedingly small, the current energy will be concentrated upon the last point of contact and tend to injure the switch.

To obviate this danger Prof. Elihu Thomson places in circuit with each of the multiple contacts an induction



coil so arranged that under ordinary circumstances no impedence is offered to the current flow, but which allow only the proper proportion of current to traverse each contact upon the opening of the switch. The increased current, tending to rush through the contact last broken, sets up a counter electromotive force that prevents its passage during the short interval between the last break and those preceding.

The accompanying illustration shows the device so clearly as to render further explanation superfluous.

INSTALLATION FOR ELECTRIC LIGHT AND POWER AT BENATEK, BOHEMIA.

[FROM OUR OWN CORRESPONDENT.]

SINCE, in 1892, a flood of the river Iser had carried away the so-called Great Mill driven by water-wheels on the left bank of the river, together with its boundary walls and installations, as also a part of the weir, the Austrian Land-bank made a proposal to the owner of the domain, "Alt-Benatek," to whom this water-power belongs, concerning the utilisation of the available power by means of turbines.

The power obtained from the turbines was to be applied, by means of electrical transmission, for working the brewery and the sugar-works (beetroot), also belonging to the domain Alt-Benatek, as also for lighting up this establishment and the head steward's offices.

It was resolved, on the basis of thorough investigations, to erect a turbine, which both with a fall of 3,500 millimetres, and also with one of only 3 metres, the rotation of the turbine remaining the same, should give a useful effect of 200 H.P., measured at the shaft of the turbine.

A further stipulation of the Land-bank was that the installation must be executed in such a manner that at any time a turbine could be introduced without interrupting in any manner the work of the first turbine; further, that each turbine could be, at pleasure, shut off and worked independently of the other, and that each might be repaired without in any manner interfering with the other, and also that both turbines might be again connected.

These stipulations involved separate channels for influx and efflux, and also a parallel arrangement of the main transmissions.

In order to secure the new installation against future floods, screens were arranged at the mouth of the influx, on which are applied powerful protective walls constructed of I and U iron to hinder the entrance of a flood.

The protective plates are suspended, two by two, on toothed rods, constructed of wrought-iron, and are raised and lowered by means of a windlass.

Determinations concerning the right to the water fixed the sections, and the heights of the water as it flows in without essentially interfering with the work of the turbines.

Behind these flood screens there are "rakes" for the turbines, in order to keep back any rubbish which might occasion damage.

For quickly cutting off the water, turning screws are applied behind the rakes. They may be actuated from the turbine house, and a quarter rotation of the axle is sufficient to cut off the water.

An indicator in the turbine house shows how far they are opened.

The turbine itself is constructed on the well-tried system of the firm Ganz & Co., as a so-called double crown turbine, the outer crown as a Jonval turbine, and the inner as a boundary turbine.

The outer crown can be regulated by means of a manual cover, whilst the inner is provided with a simple and practical valve regulator "patent Gulden."

By means of this manner of regulation it is possible at any time to shut off the turbine.

An automatic speed regulator acts also upon the inner crown in order to maintain the normal rotation in case of an alteration of the power.

The plug of the turbine is a so-called "bell-plug," such as Ganz & Co. have used with the best success in almost all their turbine installations.

This plug is distinguished for simplicity of construction, ready accessibility, and trustworthy lubrication.

On the main horizontal transmission are fixed the driving discs for the primary machine.

In order that each of these machines can be connected and disconnected without interfering with the work, the transmission discs are constructed with friction couplings.

Description of the Electric Installation.

This installation is intended

(*a*) To provide the sugar works, brewery, and the chief inspector's office with electric light, by means of water-power obtained from the Iser.

(*b*) To work various machines in the sugar works and brewery, which have hitherto been driven by steam, by means of power electrically transmitted.

The electric installation consists of three parts, *i.e.*,

1. The primary station, containing two machines for electric lighting, and two machines for the transmission of power.

2. The main lead between the primary station on the one hand, and the brewery, sugar works, &c., on the other.

3. The secondary installation consisting of the lighting arrangements in the works, in the offices above-mentioned, and in the court of the castle, as also the installations for the electric transfer of power, two in the sugar works, and one in the brewery.

At the primary station there is set up a turbine of 200 H.P., which at present works four dynamos by means of driving bands, whilst room is left for a fifth dynamo in case of further extension. For each dynamo a connection is provided at the main transmission.

Two of the dynamos at 50 H.P. serve for light, and two at 65 H.P. serve for the transmission of power. Of the two lighting machines, one supplies the regular light, whilst the other is kept as a reserve. These machines belong to the type of the Zipernowsky system, built by Ganz & Co. Each of them when making 625 rotations, and at a tension of 1,800 volts, can feed about 500 glow lamps at 16 normal candles. Each of them drives by means of bands a continuous current machine of 100 volts as an exciter.

The lighting installation, on account of the distances ($1\frac{1}{2}$ kilometre) between the primary station and the objects to be lighted, is constructed on the alternating current transformer

* New York *Electrical Engineer*.

system on which two larger works have already been executed, viz., at Marienbad and Karlsbad.

Each of the two machines for the transfer of power gives 65 H.P. at 400 rotations per minute, and a tension of 550 volts. They belong to the type of continuous current dynamos, system Ganz & Co.

The machines, both for light and power, have arrangements for tightening the bands whilst at work, and have self-lubricating journals which economises labour and oil.

Insulated wires lead from the dynamos to a general switchboard on which are placed the appliances for regulating and for connecting and disconnecting all the machines.

It is very noteworthy that the regulation of tension both in the light and power machines is effected quite automatically by the co-operation of the turbines and the electric regulators, whether lamps or motors are to be introduced or removed from circuit.

The leads outside the building consist of bright copper wires, and are secured to the wooden pillars by means of double bell insulators.

For the lights there is used a copper lead of 4 mm. in diameter; for the transfer of power two copper wire leads, each of 8 mm. diameter. The leads, where they enter and leave the buildings, are protected against atmospheric discharges by means of lightning conductors, and where they cross public roads they are insulated with caoutchouc tubing. They are laid so that the lowest wires are at a distance of at least 5 metres from the ground. Where a State telegraph wire had to be crossed by the lead for the strong current, this was done at right angles; the latter lead was conveyed above the telegraph wire and was insulated with caoutchouc tubing.

In the secondary lighting arrangements the current was carried from the open leads first to the transformers, placed in closed boxes, whereby the open leads on entering the buildings are well insulated. In the transformers the current is reduced from a tension of 1,800 volts to 100 volts, and branches off then to the several groups of lamps.

The leads inside the buildings are wires thoroughly insulated and mounted on porcelain and secured with lead.

There were installed:

In the sugar works, with the offices and dwellings, 300 glow lamps and 4 arc lamps.

In the brewery, 130 glow lamps and 2 arc lamps.

In the chief steward's offices and the castle yard, 25 glow lamps and 1 arc lamp.

In place of five steam engines formerly in use, there have been set up:

At the sugar works, 1 continuous motor, type Delta 5 for 50 effective H.P., at 450 turns per minute; also a continuous current motor, type Delta 4½ for 37 effective H.P., at 500 rotations per minute.

At the brewery, a continuous motor, type Delta 4 for 25 effective H.P., at 550 rotations per minute.

Separate closed rooms were arranged for all the three motor stations. The starting resistances possess each a regulating resistance for correctly fixing the number of rotations. The motors have self-oiling journals for minimising the quantity of work. By means of this installation all the machines in the sugar works and the brewery are driven electrically, except some direct action steam pumps at the sugar works, in which the pumps and the steam engines are constructed in one piece. But the ice machine about to be fitted up will work by electric power.

Whilst consequently the installation displays technically great improvements as compared with the former manner of working, it is to be regarded as economically satisfactory. The saving effected by the removal of the former gas and petroleum lighting and the steam work not only cover the working cost and the interest on the capital sunk, but will pay it off in a relatively short time.

Heckmondwike Electric Lighting.—The ratepayers have been polled as to their attitude in regard to electric lighting; the result shows that 725 are against, and 694 are in favour of, its adoption, majority, 31; 523 papers were returned unfilled, showing that nearly one-fourth of the electors took no interest in the matter either way.

NOVEL EFFECTS OF THE ELECTRIC DISCHARGE.*

BY LORD ARMSTRONG, C.B., LL.D., &c.

THE Literary and Philosophical Society, which has this day attained its hundredth birthday, was founded by a small number of literary and scientific persons, of whom my father was one, and his membership and my own, taken jointly, cover the entire century which has since elapsed. For 30 years I have had the honour of being president of this society, so that my association with it is of no common order, and is such as to render it fitting for me to contribute, in some way, to the celebration of its first centenary. I have, therefore, undertaken to exhibit to you this evening some electrical experiments which possess sufficient novelty to render them interesting to experts and, at the same time, entertaining to those who have but scant knowledge of electrical science.

This is not the first time that I have appeared before the members of this society to exhibit novelties in electricity. Forty-nine years ago I brought forward, in the old lecture room of the society, my first hydro-electric machine. That room was very much smaller than this one, and both it, and the only passage to it, were so densely crowded when I arrived, that I could not enter by the proper entrance, and was reduced to the necessity of climbing in by the window. On the present occasion I feel flattered by again seeing before me a very crowded audience, before whom I am able to appear without entering like a burglar.

The hydro-electric machine was my first electrical love; but soon after its introduction I became engaged in the hydraulic experiments which led to the establishment of Elswick, and from that time, to very recent years, the exigencies of business prevented my giving attention to electrical subjects; but I remained faithful to my first love, and resolved to renew my addresses if ever circumstances permitted me to do so. This I did about a year ago, but, in the meantime, I had grown old and unable to bear the necessary out-door exposure, so I transferred my affections to a less exacting mistress that would be satisfied with in-door attentions. That second mistress was the Ruhmkorff induction coil. My first endeavour was to combine induction coils in such a manner as to form a battery, just as we combine Leyden jars or voltaic cells in battery. There were many impediments to doing this, and, although I have not wholly overcome them, I have succeeded in making a very powerful apparatus upon this principle which, however, is too cumbersome to be brought here this evening, and is not required for the experiments I intend to show you.

I will first show you the spark from the induction coil on the table, which is a very powerful one, made by Apps. The short spark with which I commence consists entirely of flame, which Mr. Crookes has shown to be due to the combustion of the nitrogen of the air in its union with the oxygen to form nitric acid; then, as I gradually increase the separating distance, you will see a torrent of sparks passing between the terminals. I go on increasing up to 18 inches when sparks still continue to pass, though in reduced numbers. I will next show you some other beautiful illuminating effects and then proceed to things which, from their novelty, possess more scientific interest.

Probably many of you are aware that soon after I introduced my hydro-electric machine I designed and made a very large one for the Polytechnic Institution, which then existed in London. It proved to be by far the most powerful instrument for the production of frictional electricity that had ever been seen. It was a very short time in my hands after its completion, and I made the best use of my time in trying experiments with it in the open air. Amongst other experiments I hit upon a very remarkable one. Taking two wine glasses filled to the brim with chemically pure water, I connected the two glasses by a cotton thread coiled up in one glass, and having its shorter end dipped into the other glass. On turning on the current, the coiled thread was rapidly drawn out of the glass containing it, and the whole thread deposited in the other, leaving, for a few seconds, a rope of water suspended between the lips of the two glasses. This effect I attributed at the time to the existence of two water currents flowing in opposite directions, and representing opposite electric currents, of which the one flowed within the other, and carried the cotton with it. It required the full power of the machine to produce this effect; but, unfortunately, when it went to London, and was fitted up in the lecture room, I could not get the full power, on account of the difficulty of effecting as good insulation in a room as in the outside air. I therefore failed in getting this result, after announcing that I could do it, and I daresay that I got the credit of romancing. It has ever since been my desire to establish my veracity in this matter, and with the powerful apparatus now at my command, I speedily succeeded in reproducing the experiment in a modified form. In fact, I have done it in different forms; but the one which I shall show you this evening is as striking as any, and can be performed with the single induction coil which I have upon the table. The conditions of the experiment are as follows:—I take a glass bulb, having a long neck on one side, and a short nozzle on the other, the nozzle having an aperture of one-tenth of an inch diameter. Through this aperture a string, composed of spongy cotton thread, is passed. The string is barely sufficiently thick to fill the aperture, and is secured at the upper end by a knot, or by attachment to a conducting wire, which enters the bulb through a cork at the top of the neck. The bulb is then plunged into a glass cistern, and both bulb and cistern are filled with carefully distilled water, and the cork

* Experimental lecture delivered last week to the Literary and Philosophical Society, Newcastle-on-Tyne.

is tightly inserted in the neck. The whole is placed in the field of the lantern, so as to be exhibited on the screen. And now, all being ready, we will send a positive current into the bulb, and make the cistern negative, and if I am not again sold, as I was at the Polytechnic, you will see the cotton climb up into the bulb. You see it is so, and now I reverse the current, and it comes rapidly down. Those who are near will see that there is a clear indication of water rushing out of the aperture all round the cotton. The water, in passing the aperture, becomes a little heated, and, is rendered visible by a flicker, just as hot air becomes visible when it mingles with cold. But the bulb remains full, and if the water comes out without lessening the quantity in the bulb, an equivalent quantity must be going in by the same aperture, and as the descending column visibly flows outside of the cotton, the ascending current must flow inside the cotton, and must carry the cotton with it. The two currents become distinctly visible when the cotton is removed, and though we cannot discern their relative position until they are clear of the aperture, the facts of the case seem to demonstrate that the negative current flows inside of the positive and determines the direction in which the cotton travels. This conclusion appears to me a very interesting one, and may tend to elucidate the relationship between positive and negative currents. When the cork and cotton are removed, the level of the water in the bulb is free to rise or fall, but it remains stationary under the compensating action of the two currents. This, however, is not the case when the cotton is in operation without the cork, because the cotton impedes the current which moves it and gives the ascendancy to the outside current, and thereby lowers the level of the water in the bulb. The contrary effect is, of course, produced by reversing the electric current, and the water then rises in the bulb above the level of the water in the cistern.

In the course of experiments I was making on the dispersive effect of the electric spark upon dust, I observed that the disturbed dust always settled in circular lines. Although I afterwards found that this fact had been observed before, yet to me it was perfectly new, and, as it appeared to be a very interesting fact, I followed up the subject by an elaborate course of experiments which have yielded a rich harvest of results, revealing the hidden motions which attend the electric discharge.

I have already exhibited to the Royal Society photographs of many of the dust figures I have produced. Those photographs were of dust figures done on cardboard, and the photographs were afterwards transferred to glass and were shown at the Royal Society with the electric lantern. I will show you a few of these photographs this evening by way of introducing the subject, after which you shall see a selection of figures, in actual process of formation, on the horizontal stage of a lime-light lantern. In all these figures I shall use plates of glass with a layer of fine dust sifted over them, and shall operate upon the dust by a spark discharge acting in various ways. I use three kinds of dust, calcined magnesia mixed with charcoal in the form of lamp black, tripoli powder, and hard carbon reduced to a fine powder. These three varieties act somewhat differently, and each kind has its application in the production of the best effects. The dust is sifted upon the plates in an evenly distributed layer, and the effects are shown by the manner in which the dust is displaced by the electrical disturbances.

You are all aware that when a gap is made in a conducting wire and a spark passes between the severed points, all that can be seen is a streak of fire; but if I lay the severed wires upon the surface of a dust plate we get the figure which I will now show you by a photographic plate inserted in the lantern. You see the dust is brushed away from the track of the spark, but the action takes place sideways and not in the direction of the spark. You also see that the discharge takes place not merely from point to point of the wires, but also from the sides of both of the positive and negative wires, as indicated by beautifully regular streaks in the dust. The stronger ones being positive and the weaker ones negative. You will also see that there are circular lines faintly visible outside of the central figure, but when a Leyden jar is used as a condenser to give density to the spark, these circular lines come out very strongly, but as I shall presently show you their actual formation, I need not show you the photograph. But these circular lines are also produced by a vertical discharge through a hole in the glass, and as it is not easy to do this on the stage of the lantern without piercing the lens, you must be content to see the photograph which shows the circular lines very distinctly. Another figure involving the same difficulty must also be shown by photograph. It exhibits a dust plate with six small glass pillars erected upon it to obstruct the motion of the dust. You see the lines are now diverted from the circular form and thrown into arches from pillar to pillar, while the spandrels are filled with inverted curves. You will also see that the ends of the arched lines cling to the glass pillars, notwithstanding the outward drift of air, thereby indicating a strong attraction between the dust and the pillars. I will now dismiss the photographs and proceed to show you the formation of the figures upon the horizontal stage of the lantern, and this is a thing which has not yet been exhibited in public. I will begin with an experiment in which the dust is thrown into circular lines by an electric discharge from a Leyden jar, passing between wires parallel with the surface of the dust, and sufficiently raised above the surface to avoid the sweeping action of the air blast, and I expect you will see the movement in great perfection on the screen. You observe that the dust is thrown into circular lines up to the very centre, and a close inspection also shows a very active reciprocal motion amongst the dust particles themselves which seems to indicate a transmission of electricity by convection. I will now take another dust plate and raise the sparking points to such a height as will save the dust from any disturbance by the discharge. You shall see the dust plate first and notice that the spark has no effect upon it; but I will now place upon this dust plate a piece of sheet lead cut into the form of a cross, and supported on four needle points at a distance of one-tenth of an inch above the dust. You would naturally expect that this sheet lead acting as a shield would give to the underlying dust additional security against disturbance. But now, after passing a few sparks without effecting any disturbance of the exposed part of the dust, I lift the cross and you see that the shielded part of the dust is thrown into beautiful symmetrical curves depicting the figure of the cross.

We may go a long way towards an explanation of these curious effects by saying that the particles of dust are polarised, and separated into wave lines by atmospheric vibrations. We may also infer that, if the discharge were made in a dense atmosphere of dust, the figure formed by it would be globular and be composed of concentric shells, with small intervals between them, so that, if cut through, either vertically or horizontally, the shells would be presented in section, and the edges would coincide with the lines we see on the dust plate. But these views, though probably correct so far as they go, are greatly short of what is required to clear up the whole subject, and for the present I must be content to show you the results without attempting to fully explain them.

I will now discard the Leyden jar and bring the wires down until they lie upon the dust-plate and will take very gentle sparks direct from the coil. On doing so you see the track of the spark and the off-shoots from the wires. You will also observe that the off-shoots from the positive wire bend round the spark track to get at the negative, while the negative off-shoots seem to make no effort to get round by the outside of the positive. I am therefore led to believe that the negative current follows the inner course and the positive the outer one, and this is in unison with the cotton experiment, which presented every appearance of an internal and an external current, the inner being the negative current and the one which carried forward the cotton. And now you shall see a very beautiful figure, caused by splitting the positive current and bringing it up to the sparking points in two lines curved in a manner to show how the dust-streaks behave towards each other. The field is not large enough to show the whole figure at once, but by moving the dust-plate you shall see it all in parts. There is the figure, and you see a very marked distinction between the inside streaks and the outside ones, which is explained by the fact that the insides face and oppose one another. You see also various dark spaces which show absence of disturbing action, and there is a very peculiar dark band running parallel with the wires, which may be due to a jumping motion from the surface of the plate. You would hardly expect to see such a revelation where nothing was to be seen before but a tiny spark.* But we will now banish this spark to a distance and operate upon the dust with the electric emanations from the wires alone, or from metallic terminals in contact with them. The positive and negative wires will then be mere branches from the main circuit, and the spark will take place on the main line and not between the branch terminals. In the first place, I will draw down the point of the positive branch vertically so as to touch the centre of a dust-plate. There is a lead ring serrated on the inner edge surrounding the dust-plate to which the negative branch may be attached, although it does not make any difference beyond exalting the effect, whether I attach it or not. When I turn on the current you see that a circular figure is established on the plate showing radiations which represent the transverse view of what you have seen before. It is probable that self-induction is the operative principle in the production of this sparkless figure; but I observe that whenever electricians are at a loss for an explanation they mystify their hearers by attributing the effect to self-induction, and I find it convenient to follow the practice in this instance. You will perceive a slight negative effect proceeding from the ring, but I now reverse the current, and you then see a splendid display of streamers pouring inwards from the circumference to the centre. A still more beautiful effect will be displayed in the next figure, in which the central part of the plate is occupied by a slender cross of sheet lead pointed at the tips. The influence of the points in the formation of this beautiful figure is very conspicuous. Another variety of figure, equally beautiful, is shown by placing on the dust plate a strip of sheet lead, saw-shaped on both sides. In the last three experiments I have used tripoli dust, which is a very imperfect conductor, and has a slight adhesiveness to glass, which makes it show the pencillings more distinctly. But I will now use carbon dust, which is a good conductor, and you will find quite a new effect is produced.

I shall use no spark on the dust plate, and operate with branch wires from the circuit as before. In the first place I shall bend down the negative branch perpendicularly, and cause it to touch the dust plate in the centre, and I shall apply the positive branch to the lead serrated ring which surrounds the dust plate. You see the dust rolls up in massive circular waves from the circumference to the centre, followed by beautiful streamers from the surrounding points, and altogether presenting a most extraordinary figure, and one of great beauty. I will next put the four-pointed star already used in the centre and proceed the same as in the preceding experiment. You see a figure widely different from the last, and not less beautiful. These dust figures may be multiplied in endless variety; but time will only permit of my showing you one more. I substitute for the four-pointed star a lengthened piece of lead, with parallel serrations on the two sides, and I take away the lead ring, together with the positive branch wire attached to it, and I place the positive wire in contact with the piece of lead now placed in the centre. As I have removed the negative wire, you will observe that the positive terminal acts alone without any opposite terminal, yet you will see that a figure is produced involving forms and motions which words can

* To obtain this figure in perfection, as well as all others in which tripoli powder is used, the plate should be rendered very slightly adhesive by waxing or greasing the surface, and then rubbing off the material with the fingers until scarcely any of it remains.

hardly describe; but, like all the others, distinguished by symmetry and beauty.

And now I have only one more remark to make. There will be some amongst you who will ask of what use are such experiments as these? I answer that the more we pry into the mysteries of electricity the more we shall be able to apply it to the service of mankind; but, apart from that consideration, knowledge, for knowledge sake, is a worthy object of pursuit.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AN ordinary general meeting of the Institution was held on Thursday, February 9th, Mr. W. H. PREECE, F.R.S., president, in the chair.

The minutes of the last ordinary general meeting having been read and approved,

The PRESIDENT announced that the Institution had received from Sir David Salomons a donation of £500 New South Wales 3½ per cent. Stock, to be added to the Salomons Scholarship Fund; and also at the same time he had presented £20 for the Benevolent Fund.

The discussion on Prof. Fleming's paper was then continued.

Prof. AYRTON: Dr. Fleming has given a great amount of attention to an examination of the accuracy of the three-voltmeter method of testing the power given to an alternating current circuit and other methods based on the three voltmeter method, but I do not think Dr. Fleming quite understood the way in which we proposed the three-voltmeter method should be used. We do not propose that every time we wish to measure the power given to an alternating current circuit that we should employ the three-voltmeter method. What we intended was to furnish everybody with a method which would enable him to check the accuracy of the more ordinary measuring instruments. It is a method which only requires the use of ordinary measuring instruments, a voltmeter, an alternating potential difference voltmeter. So far it is simple enough, but as you know it takes a little longer to make the measurement; you have to read three instruments. But what we intended was that you should check the accuracy of your instruments by means of this instrument; it supplies you with a means of ascertaining whether your wattmeter is correct. In fact we look on the three-voltmeter method very much as we look on the Kelvin balance. Whenever you want to measure current, you do not use the Kelvin balance—that would be far too troublesome; we only use it to test the accuracy of the ordinary ammeter. I am very glad that Dr. Fleming has found so convenient and accurate, what Dr. Sumpner and I some time ago described at the Royal Society, a method of using a low resistance pressure coil wattmeter. It has been called a split dynamometer, and other names have been given to it, but as Dr. Fleming and we have used it, it is simply a wattmeter, and instead of having a very high resistance in the voltmeter or the wattmeter, we have a very low resistance, for a very simple reason, as we pointed out in one of the papers read before the Physical Society which was published, in which we found that if you have a low resistance pressure coil to your wattmeter any error due to self-induction in the pressure coil was enormously diminished. No doubt you waste a good deal more power in making your measurement, but, if you are anxious to get a perfectly accurate result, the waste of power in the wattmeter itself is quite unimportant compared with the accuracy you can obtain. Waste of power, of course, does not enter into the measurement; it merely means that your dynamo has to do a little more work. With reference to electrostatic voltmeters, I do not quite understand why a greater accuracy was not obtained with the voltmeters Dr. Fleming employed—electrostatic voltmeters. A reflecting electrostatic voltmeter he used, a zero instrument, turning something or other to zero every time he made a measurement; still, if I remember aright, the percentage of accuracy was not very great. In this room Mr. Mather and I have shown electrostatic voltmeters which did not require the use of a mirror or ray of light, which were direct reading instruments, without any zero adjustment, and we found that with this in the working part of the scale, you can read to an accuracy of one-tenth per cent. I will mention the fact that with the cylindrical device of needle, the circular form of needle, as opposed to the flat form of needle made by most makers, you can get an accuracy far greater than with the flat form of needle. There has been a great deal of discussion about what is meant by effective current and virtual current. An effective current must depend upon what is the effect you want to produce. Suppose you take a direct current dynamo which does not produce an absolutely steady current, and, of course, that machine could be employed for depositing metal, although the current is not absolutely steady. Now, the amount of metal that is deposited depends on the mean value of the current, so that the effective current in that case is the mean current. That same machine could be used to make lamps glow. There the light depends on the mean square of the current, so there the effective current should be the mean square. You might also have the machine designed to produce a steady potential difference, shunt it with the condenser, and there would be a small alternating current through the condenser. Now, the effective E.M.F. for producing that current is neither the E M.F. of the machine nor the square root nor the mean square of the E.M.F., but the rate of variation of the E.M.F.; clearly, then, the effective E.M.F. ought to mean something totally different, depending upon the effect you want to produce. Virtual current, I suppose, is a current virtually equivalent to something else. The D'Arsonval galvanometer measures the mean current. Let us then call it the mean current—the m current; the m current then is what the D'Arsonval galvanometer measures. An ammeter with a soft iron needle, or an electro-dynamometer, measures the mean square of the current. Let us call that the $m\,s$ current. If you graduate your dynamometer—which is very rarely done, I don't know why—so that the square roots of the deflections are taken, then you get what has been sometimes called the effective current, sometimes the virtual current; that is really the root of the mean square of the current. I propose, therefore, to call it the $r\,m\,s$ current.

(To be continued.)

NEW PATENTS—1893.

2,010. "Improvements in electricity meters worked from a central position." W. H. SCOTT. Dated January 30th.

2,044. "Improvements in mechanical pianos or other musical instruments worked by electricity." Sir D. L. SALOMONS. Dated January 30th.

2,059. "Improvements in or relating to telegraphy." A. HEIL. Dated January 30th. *(Complete.)*

2,129. "A method and means for producing mica rings or discs suitable, principally, for insulating purposes." R. HADDAN. (Communicated by C. W. Jefferson, United States.) Dated January 31st *(Complete.)*

2,134. "Improvements in porous vessels, or pots and diaphragms for secondary and primary batteries." G. LENTZ. Dated January 31st.

2,145. "Improvements in dynamo-electric machines." H. H. LAKE. (Communicated by R. Lundell and E. H. Johnson, United States.) Dated January 31st. *(Complete.)*

2,159. "Improvements in or connected with electric arc lamps." J. H. ROSE. Dated January 31st.

2,161. "Heating liquids by electricity." L. B. MILLER and M. W. WOODS. Dated January 31st.

2,167. "An improved apparatus for registering telephone calls." L. KAHN. Dated January 31st.

2,182. "Improvements in apparatus for transmitting movements or indications by electricity." T. O'BRIEN. Dated February 1st.

2,190. "Improvements in field magnets." C. B. CRAWSHAW and C. WRAY. Dated February 1st.

2,191. "Improvements relating to telephone transmitters." H. A. C. SAUNDERS and A. C. BROWN. Dated February 1st.

2,199. "An instrument for the measurement of electric currents." W. THOMSON, BARON KELVIN. Dated February 1st.

2,202. "Improvements in photographic printing by electric light, and in apparatus therefor." J. E. A. GWYNNE. Dated February 1st.

2,203. "Improvements in alternating current arc lamps." J. E. A. GWYNNE. Dated February 1st.

2,241. "High-tension battery." C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. Dated February 1st.

2,242. "Improvements in electric cooking or heating apparatus." Sir D. L. SALOMONS. Dated February 1st.

2,267. "Improvements in the method of and apparatus for the electrolytical separation of the bases of salts, and of compounds of the same from saline solutions." C. T. J. VAUTIN. Dated February 1st.

2,272. "Improvements in electric light hangers or supports." H. L. HOLT. Dated February 1st.

2,280. "Electric toy." J. D. ENGLAND. Dated February 2nd.

2,311. "A new or improved apparatus for the electrolysis of saline solutions." J. B. HANNAY. Dated February 2nd.

2,318. "Electric tool." G. H. WILLIAMS. Dated February 2nd. *(Complete.)*

2,320. "Electro-chemical cementation for separating copper from solutions by means of iron." R. CONEDERA. Dated February 2nd.

2,329. "Improvements in the manufacture of white lead electrolytically." J. C. RICHARDSON. Dated February 2nd.

2,331. "Improvements in secondary electric storage batteries or accumulators." N. H. EDGERTON. Dated February 2nd. (Date applied for under Patents Act, 1883, Section 103, 11th July, 1892, being date of application in United States.)

2,334. "Improvements in electric incandescent lamps." E. BAILEY and G. M. GORDON. Dated February 2nd.

2,361. "An improved depolarising material for galvanic elements." F. SZYMANSKI. Dated February 2nd. *(Complete.)*

2,375. "Improvements in and relating to insulating supports for electrical conductors." A. R. BENNETT. Dated February 3rd.

2,381. "Improvements in and relating to ships' telegraphs." J. W. RAY. Dated February 3rd.

2,402. "Improved electrical alarm for use in connection with steam gauges." A. T. MIRZA. Dated February 3rd.

2,403. "Improvements in the means of distributing electrical energy, and in dynamos and other apparatus therefor." J. A. KINGDON. Dated February 3rd.

2,455. "Improved friction coupling for the carbon feed mechanism of electric arc lamps." J. JERGLE. Dated February 3rd. *(Complete.)*

2,463. "Improvements in, and apparatus for, the electrolysis of solutions of salts or compounds of the alkalies, more especially intended for the manufacture or production of alkalies and chlorine, and for bleaching." J. MARX. Dated February 3rd.

2,494. "Improvements in telephone annunciators." A. WHALLEY. Dated February 4th. *(Complete.)*

2,520. "Improvements in apparatus for automatically indicating and registering the score obtained in electric target practice." A. J. ELI. Dated February 4th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

8,009. "Improvements in and relating to electric call apparatus." G. POORE. Dated May 9th. The inventor applies to an electric call or signal transmitting apparatus a coin operated mechanism, and he so arranges the internal parts that, upon the insertion of a coin or token, a part is released, and the operator is enabled to pull out a drawer or equivalent device, which may bear or contain one of a number of cards, writing materials, or other thing or things applicable to the purpose intended, and contained in the apparatus. This action serves to store up sufficient power by spring, weight, or equivalent action to actuate the transmitting mechanism when required, and the same action, should the line be clear, also serves to release the power storage mechanism, and so operates the transmitter and despatches the signal. If, however, the line is engaged at the time of the operation, the power storage mechanism is not at once released, but retained and delayed by suitable self-acting mechanism until the line is clear. 9 claims.

8,874. "Improvements in or connected with telephones and electric bells." J. F. BENNETT and E. P. HIDES. Dated May 26th. Relates more particularly to the construction of self-contained portable telephones, in which any suitable kind of battery may be used, but preferably one or more composed of carbon slabs placed in zinc cases, and filled with a solution of plaster of Paris and salammoniac, and sealed with cement. One of the chief objects is to produce an instrument of very compact form, and constructed so that the lid can be taken off, the batteries taken out, and replaced by new ones, and the connections made with certainty by a person having no knowledge of the instrument. This is accomplished by a system of spring connections; thus when the battery (or batteries) are put in the outer case, the zinc case presses against a spring connection, making the contact with the negative pole, and also acting as a retainer to prevent the battery moving about in case. 4 claims.

9,048. "An improved method of and means for illuminating road vehicles electrically." F. COGAN, T. WRIGHT and R. COLLINS. Dated June 20th. The object of the invention is to provide a means for illuminating cabs, carriages, and road vehicles generally, by the use of suitable lamps of low voltage, rendered incandescent by a current of electricity, generated, either by the employment of a specially constructed primary battery, or secondary cell, placed in any convenient part of the vehicle, but preferably, in the box forming the seat of the driver, suitable leads and switches being employed to convey the current to the lamps, which may be situated either within, or without the vehicle, and arranged so as to be under the control of the driver, or the passenger, where necessary; suitable resistance coils may be interposed within the circuit, to regulate the current. 2 claims.

9,887. "Improvements in and relating to microphonic or telephonic transmitters." A. T. COLLIER. Dated June 11th. Relates chiefly to the suspension or support of one of the carbon or other contacts, or of one set of such contacts, in such a manner that the said contact or set of contacts is self-adjusting, that is to say, the said contact or set of contacts is capable of angular movement so that it can freely alter its position relatively to the other contact or set of contacts, and thus ensure uniformity of pressure between the contacts throughout the entire operative surfaces thereof, and, at the same time, avoid jarring by separation of the said contacts while the transmitter is in use. 3 claims.

10,832. "Improvements in electrical tranformers." WOODHOUSE AND RAWSON UNITED, LTD. (Communicated from abroad by E. Preschlin, of Germany.) Dated June 25th. The inventor takes iron sheets of rectangular shape, in which he forms in any convenient manner two rectangular holes parallel to one another, thus leaving an intermediate piece, which will form part of the yoke of the transformer. He next punches or cuts out in any convenient manner, these said intermediate yoke pieces in such a way that each succeeding piece is slightly larger in one direction than the one before it. He now takes these pieces of iron from which the yoke pieces have been removed, and piles them successively as stamped, one on the top of the other, with intervening sheets of paper or other suitable material, forming a prismatic hollow body having a tapering groove at each end of the hollow, then in the same way he takes the yoke pieces, which when piled one on each other, form a wedge which can be slipped into the above-mentioned grooves, or he may stamp the pieces which together form the yoke of such a form as to allow them to be tightly wedged into the recess formed by the pieces from which they have been stamped. On the yoke are slipped the coils forming with it the core of the transformer and being held in place by two bolts through the top plate of the yoke, thus securing it to the body of the transformer. 3 claims.

10,877. "Improvements in or connected with means of connecting ropes or cords, and hauling electric or other cables." A. A. VOYSEY. Dated June 26th. The strands of the cable, in the case of its being covered with insulating material, are bared. Over this end, consisting of the copper or other strands, is fitted a ring or equivalent metal ferrule which may be tapered on the inside, the enlarged part being nearest the end of the cable. In connection with this, is employed a pin which is driven into the end of the cable, by which means the strands are spread outwards and pressed firmly on to the inside surface of the ferrule, and thus the cable and ferrule are firmly fixed together; and the tendency of the ferrule, when pulled away from the end of the cable, is only to make the bond the tighter. On to the ferrule is screwed or equivalently fitted a cap to which is connected the hauling or drawing rope. When this cap is screwed on to the ferrule, the means of pulling or hauling it is complete. 3 claims.

11,004. "Improvements in and relating to the manufacture of plates for electric accumulators." C. ROUSSEAU. Dated June 27th. According to the invention, the plate of lead is cut out and provided with openings, which may be round, oblong, or of any other suitable form. The frame thus formed may be provided round the said openings with recessed parts for obtaining a better adhesion of the paste employed. The material designed to be reduced to spongy lead and to peroxide, such as sulphate of lead, salts of lead, oxide of lead, or carbonate of lead, but preferably sulphate of lead, is diluted with chloride of sodium for preparing the said paste. This paste is then applied to the frame above-mentioned in such a manner that there shall be as much below as above, and that the frame shall be concealed in the paste, the thickness of the coating formed on both sides being varied according to requirements. The sulphate of lead is first dried, reduced in a bath of salt water, then passed between rollers and put in the circuit in order to transform it into spongy lead for the negative plates, and into peroxide for the positive plates. The inventor adds to the paste when diluting it, as also in the case of other salts or oxides of lead, hair cut to the length of about one centimetre, with the object of giving it a perfect homogeneity, the perforated frame performing merely the part of an interior support. 2 claims.

11,016. "Improvements in armatures of dynamo-electric machines and electric motors." H. L. CALLENDAR. Dated June 29th. The inventor makes the armature of spirally laminated discs, constructed of flat bars or strips, preferably of iron, in the following manner:—A number of radial bars or strips are firmly attached to a suitable hub, which may also serve as a commutator. The strips are insulated from each other throughout their length, and are all bent round in the same direction so as to lie close together, forming a nearly solid and rigid disc. Each strip will then approximately take the form of a part of the involute of a circle. Two or more such discs are fixed side by side on the same axis, with their spirals in opposite directions. The spiral laminæ of opposite discs are connected in series, alternately at the edge and at the hub, and to a commutator of the ordinary pattern, in such a way as to form a "closed coil armature." 2 claims.

11,048. "Improvements in the preparation and laying of electrical mains on the Brooks system." W. C. JOHNSON and S. E. PHILLIPS. Dated June 29th. The inventors draw or force dry air through the pipes after they, together with their junctions, or draw-in boxes, are properly connected up in the position and situation which they are to occupy. They also draw or force the heated fluid dielectric into the system of pipes and boxes after the cable or cables have been drawn in, thus ensuring that all air and moisture are removed from the pipes and boxes, and that they are completely filled with the dielectric. For the purpose of aiding the complete removal of all traces of moisture from the pipes, boxes and cables, they draw or force dry air through the system after the cables have been drawn in, but before the dielectric is introduced; and, to facilitate the drying and subsequently the filling in with the heated dielectric, they heat the cables or conductors by passing a sufficiently large electric current through them, or they apply a current sufficient to heat smaller conductors which may be drawn into the pipes with the main cables and which may be afterwards used as potential wires, or for other purposes. 6 claims.

11,060. "Improvements in thermo-electric batteries." P. GIRAUD. Dated June 30th. One electrode of each element is formed of an alloy of zinc, antimony, copper, tin, silicium, and cadmium. The other electrode of each element is preferably composed of blades or plates of tinned iron or of pure nickel; they may, however, be made of iron iridiumised, platinised, or nickeled on its surface, or of ferro-aluminium. 10 claims.

11,157. "Improvements in transmitters for telephones." J. RADCLIFFE and J. E. SPAGNOLETTI. Dated July 1st. A diaphragm of metal or other suitable material is employed, which is put into vibration in the usual manner by the air waves caused by the voice. To the back of the diaphragm is attached a small disc or button of carbon, or other suitable material. A permanent horse-shoe magnet is placed in a plane parallel to the plane of the diaphragm, or in some other convenient position, at a suitable distance behind the diaphragm and insulated from it. A metallic non-magnetic bar is fixed across the two limbs of the magnet, and at right angles to them and to this bar is attached the fulcrum, or support upon which a metallic lever is free to swing through a small angle. One end of this rocking lever is provided with a light piece of soft iron which acts as the armature for the permanent magnet. The other end of the rocking lever is provided with a screw, the end of which is preferably tipped with carbon, and comes in contact with the carbon disc or button attached to the diaphragm. 2 claims.

14,517. "Improvements in microphones." SIEMENS BROS. & Co., LTD. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated August 27th. The diaphragm has a fixed carbon plate, and is made rotatable together with the mouthpiece, as in previous inventions; but in place of a single central carbon cone, resting in a coned cavity of a fixed block, the inventors employ two or more, by preference three, carbon cones, arranged symmetrically round the central axis of the instrument, and resting in a corresponding number of coned cavities in a metal, carbon, or other plate carried by a very flexible disc of metal foil, paper or woven fabric fixed at its circumference to the casing. At the rear of this disc is an adjustable helical spring pressing it forward or upward with a certain elastic pressure, so as to cause the flat bases of the carbon cones to bear against the carbon plate of the mouth-piece diaphragm with a corresponding pressure. The diaphragm is fixed to the mouth-piece, and its edge projecting beyond the latter is rotatably confined beneath

a metal ring fixed to the microphone casing, so that by turning the mouth-piece and diaphragm, the contact surfaces between the carbon plate and the base of the cones can be changed. 1 claim.

22,657. "An electrical signalling system." A. WATTS. Dated December 29th. Relates to a novel system for the transmission of signals or messages, and is especially adapted, among other things, to be used as a fire alarm system. 46 claims.

CORRESPONDENCE.

Non-Synchronous Motor for Ordinary Alternate Currents.

In your issue of January 27th Mr. A. Reckenzaun publishes a communication from Mr. C. E. L. Brown on the above subject. For those who have followed the literature or have been engaged in the development of alternate current motors, it is of interest to know the way in which Mr. Brown uses the methods of Elihu Thomson and N. Tesla in the construction of his alternate current motor.

It is evident that the development of a good alternate current motor is of first importance for the distribution of power, and that the experience gained in the construction of multiphase current motors is of the greatest value in the construction of single-phase motors.

The Oerlikon Works are well known as constructors of multiphase motors, and, recently, a table of results was published by Mr. E. Kolbin; they have, also, for some time, been constructing motors for ordinary or single-phase currents, and early in 1892 the first motor was built. It was not a complete success, but by repeated experiments and careful study they succeeded in constructing a series of motors as standard types of the following sizes: $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{4}$, $1\frac{1}{2}$, 2, 3, $4\frac{1}{2}$, 6, 9 H.P. These motors have neither commutator, brushes, nor contact rings, they run non-synchronously and their efficiency is very nearly equal to that of multiphase motors.

In Chur (Switzerland), where the Oerlikon Works have fitted up an alternate current central station, there are three of these single-phase motors running, namely—a 2 H.P. motor driving the printing machinery of the *Neue Brindner Zeitung*, a $4\frac{1}{2}$ H.P. motor on the premises of Mr. Schmid, butcher, and a 9 H.P. motor used for starting the 100 H.P. synchronous alternate current motor in Messrs. Lendi and Parli's mill.

The inducing winding of these motors is either "Gramme" or "drum" wound and is embedded in grooves in the laminated iron. The induced or rotating part carries a winding which is short-circuited in certain groups or with complete ring at each side.

For starting, the rotating part must be given a certain speed. This can be done in various ways, viz: for the smaller sizes a pull on the left is sufficient; the motor will then get up the proper speed itself and take the load. To start with a load the method given by N. Tesla may be adopted, that is to say, the method given by Mr. Brown in figs. 12, 13 and 14.

Another method pointed out at the same time by Dr. Behn and the writer, is used by the Oerlikon Works, namely, the inducing winding is divided into several sections and is connected with the segments of a current reverser (built up like a collector) fixed on the switchboard. By means of a hand-wheel with double brush contacts sliding on the segments of the current reverser, a rotating field is produced and the motor will start; the motion of the brushes on the current reverser can then be stopped in any position.

A third method, suitable for large motors, has been devised by the writer; it is quite similar to that shown by Mr. Brown in the figs. 17 and 18. The following extract from the specification for provisional protection sent to the English and American patent offices in the last year will show the full similarity.

Extract from specification: "The armature is assumed to be a Gramme ring. As in a continuous current machine, the separate bobbins are connected with the segments of a collector on which slide two brushes. On starting the motor the primary current is supplied, not only to the field, but also to the armature. The alternate current motor now works with correct position of the brushes like a series motor for continuous current. The maximum current in the armature always coincides with the maximum field. The motor will, consequently, start under favourable conditions and with considerable torque. The resistance included in the circuit allows the strength of current and torque to be regulated. As soon as the armature approaches the synchronous motion, which takes place in a short time, the collector segments are short-circuited with each other. For this purpose serves an insulated ring, capable of sliding on the shaft and which is slid by means of a lever against the collector plates. The current now paces directly from one brush to the other. The sparking on the collector is entirely obviated, and the armature works as a short-circuited armature. By the use of a short-circuiting device, the brushes can be entirely removed from the collector after starting the motor. By means of a centrifugal governor, the pulling in and out of gear of the short-circuiting ring can be effected automatically, &c."

E. Arnold.

Oerlikon, *February 8th*, 1893.

The Telephone Judgment.

In the author's preface in chapter lxiii of Tristram Shandy, there occurs the following:—"But in answer to this Didius, the great lawyer, doth maintain and make fully appear, that an illustration is no argument: nor do I maintain the wiping of a looking glass clean to be a syllogism—but you all, may it please your worships, see the better for it; so that the main good these things do, is only to clarify the understanding previous to the application of the argument itself, in order to free it from any little motes, or specks of opacular matter, which, if left swimming therein, might hinder a conception and spoil all."

There was, once upon a time, a common, a real common, with public rights of way and pasturage, &c., for the common advantage of the whole community, and no two individual commoners could, in any way, pretend to apply any principle "on the basis of their being absolute owners" of it.

Among the more important of the animals recently introduced, and nurtured for its profit by the community, there were two which, while differing widely in all other qualities and adjuncts, had this in common that they were *both graminivorous*—one of these was a sort of cart horse, but bigger; the other was a sort of carrier pigeon but much smaller.

Now, the pigeons being delicate fastidious little creatures, it was soon noticed that their stomachs were upset by the cart horses, who were decidedly coarse feeders, and, besides, they used to get "the jumps" from fright at seeing the cart horses so close.

So the pigeon farmers said to the carters, "Go and take your big brutes away? they are spoiling the grass for our pigeons."

"Why, no," said the carters, "we have as much right to the common as you have, and it is not only our big cart horses but that herd of bright bays; and they cannot even eat with their own bigger cousins, the real carrier pigeons, without its disagreeing with them; it is you who should keep *them* to *themselves;* and besides our carthorses at most stray a little way on either side of our beaten tracks."

"Your beaten tracks!" screamed the little pigeons, "We have as much right to the roads as you have."

"Why, no," said the carters, "the roads are for traffic and draught which we do; that is their *raison d'être*; and if you find the noises disturb your nerves, it is not a hardship to you to avoid them; but, if you must come, provide perches where wanted, which will keep you quite secure."

"Perches be hanged!" said the carriers. "We will force you to fence your big brutes in, and then only we shall feel secure."

"Be reasonable," said the carter; "the little bit of common you want for yourselves is one billion times less* than what we should have to fence, and, even if we did, the complication of gates and drawbridges would so greatly interfere with our doing the cartage for the community as to practically stop it."

But the pigeon farmers would not listen to reason.

Frank Wynne.

February 14th, 1893.

* Professor P. G. Tait has calculated that the current which works the telephone is about a thousand million times less than the current used in ordinary telegraphic work.—FLEEMING JENKIN.